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MISSOURI

BOTANICAL GARDEN.

SEVENTH ANNUAL REPORT.

ST. LOUIS, MO.:
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A STUDY OF THE AGAVES OF THE UNITED STATES.*

BY A. ISABEL MULFORD.

A GENERAL ACCOUNT OF THE GENUS.

Jacobi,† Koch,‡ Terraciano,§ and Baker‖ in their works upon the genus Agave have all given attention to forms occurring within our territory. Dr. John Torrey made a good study¶ of those collected in connection with the Survey of the United States and Mexican Boundary under Lieutenant Emory. But Dr. Engelmann's ** able paper still remains the only monograph specially devoted to our species, and is still the most complete and best authority concerning them. In connection with his manuscript notes and drawings relating to the genus, it forms one of the many monuments of his skill and patient industry.

During the years that have intervened since 1875, our southwestern territory has been more extensively explored and is much better known. It was hoped that a further study of this genus might add to our knowledge of its species, and of their distribution. No place could be more appropriate for such a work than the Missouri Botanical Garden. In its large succulent house the collection of our own and foreign

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* Revised from a paper written as a thesis in connection with work for the degree of Ph. D. in Washington University, June, 1895.

† G. A. von Jacobi, Versuch zu einer systematischen Ordnung der Agaveen. 1864. Zweiter Versuch, etc. 1870. Hamburg.

‡ Karl Koch, Agaveen Studien. 1865.

§ Achille Terraciano, Primo Contributo ad una Monographia delle Agave, Napoli. 1875.

‖ J. G. Baker, Handbook of the Amaryllideae, London. 1888.

¶ J. Torrey, Botany of the Boundary, 1858, 213.

** Transactions of Academy of Science of St. Louis, iii. 291 to 322. Reprint issued December, 1875, 3 to 35. Botanical Works of George Engelmann. Collected for Henry Shaw, 1887, 300 to 325.

Agaves is probably the most extensive in the United States. It was the scene of Dr. Engelmann's labors. It still contains many of his plants, and young plants raised from them. Its herbarium contains his type specimens, manuscript notes, drawings, and reference books, in connection with its large collection and library.

Every possible facility has been afforded me in this study. Much trouble has been taken to open correspondence with residents in the Agave regions, and to obtain fresh material from the field. I am grateful for the opportunities given, and very especially so to Dr. Trelease; had it not been for his kindly suggestions, encouragement and assistance, the work would not have been possible.

I have also had the use of the specimens in the Gray Herbarium of Harvard University, and the herbaria of Columbia College and the United States Department of Agriculture. I wish to express my thanks to Dr. Robinson, Dr. Britton and Dr. Coville for the use of the material in their charge, and to Mr. T. S. Brandegee for the use of his private collection.

Thanks are also due, for much courtesy and assistance, to the following persons: —

Professor P. H. Rolfs, of Lake City, Mr. H. J. Webber, of Eustis, Mr. C. T. McCarty, of Ankona, Mr. Kirk Munroe, of Cocoanut Grove, Florida; Mr. C. G. Pringle, of Charlotte, Captain John G. Bourke, U. S. A., of Fort Ethan Allen, Vermont; Dr. J. T. Rothrock, of West Chester, Pennsylvania; Mr. C. R. Dodge, of Washington, D. C.; Dr. E. A. Mearns, U. S. A., of Fort Myer, Virginia; Dr. B. D. Ten Eyck, U. S. A., of Eagle Pass, Dr. B. D. Taylor, U. S. A., of Fort Bliss, Professor C. H. Tyler Townsend, of Brownsville, Mr. G. C. Nealley, of Corpus Christi, Mr. J. N. Gilcrease, of Sierra Blanca, Mrs. Anna B. Nickels, of Laredo, Mrs. Maud M. Briggs, of El Paso, Texas; Mr. M. E. Jones, of Salt Lake City, Utah; Mr. C. R. Orcutt, of San Diego, Mr. S. B. Parish, of San Bernardino, Mr. F. Sutphens, of Witch Creek, California;

Dr. T. E. Wilcox, U. S. A., of Fort Huachuca, Dr. P. T. Straub, U. S. A., of San Carlos, Dr. Berkeley Macauley, U. S. A., of Fort Apache, Professor James W. Toumey, of Tucson, Arizona; Professor E. W. Wooton, of Las Cruces, Dr. James K. Kimball, U. S. A., of Fort Wingate, Mr. and Mrs. C. B. Allaire, of Deming, Mrs. D. C. Billings, of Las Cruces, Mrs. J. A. Baird, of Las Cruces, Mrs. Angus Campbell, of Cliff, and to Dr. and Mrs. W. O. Owen, Quartermaster James E. Brett, Captain and Mrs. A. C. Markley, and Colonel and Mrs. Jacob F. Kent, of Fort Bayard, New Mexico.

The work has been a most interesting one. It has opened up to me a number of questions, some of which, no doubt, could be soon answered by proper field work, while others would repay careful study through a series of years.

In the genus Agave, Baker * recognized one hundred and thirty-eight species, and quite a number have been since described. As our knowledge increases, it is probable that the number which will stand as legitimate species may be much reduced. Many descriptions have been made from plants growing in European greenhouses whose inflorescence is unknown. Some of the old descriptions are so meager as to give no certainty as to the plants described; others so minutely describe single conservatory plants whose counterpart has never been seen, that the names given probably stand for these isolated plants.

Young plants of a given species may differ from one another, and from the mature plants, so greatly as to be unrecognizable. Under the changed conditions in which they are obliged to live in greenhouses, these plants frequently develop peculiarities which may or may not repeat themselves in successive generations and which may or may not be found in the natural state.

Owing to the size and weight and formidable armor of the Agaves, as well as the difficulty in pressing and drying

* Handbook of the Amaryllideae. 1888. London.

so as to make good herbarium specimens, they have been very generally avoided by collectors, and consequently are poorly represented in herbaria. Those collectors who have been able to take the time and trouble necessary, have perhaps not found them in flower, and have been obliged to content themselves with leaves or parts of leaves; others seeing a plant in bloom have been interested in getting the flowers, and have found themselves sufficiently burdened without collecting the leaves. It is comparatively seldom that leaves, flowers, capsules, and seeds of a given species have been collected by one person or in one place. Quite frequently specimens have been selected because of something unusual in their aspect, while the ordinary form has been passed by with the assumption, fancied or real, that some one else has collected that. It is often hard to tell what herbarium sheets may or may not be placed together to represent a plant.*

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* Botanical collectors, are, as a rule, much interested in their "finds," and wish to have good work done with them. They are usually well aware of the fact that field notes of all salient points that cannot well be shown in dried specimens are very valuable. These should include notes of habit, surroundings, color of flowers, pollination, maximum, minimum, and average size. Where variable, it is very desirable that leaves should be selected representing different stages of development in both young and mature plants, and that careful notes of abnormal forms should be made. Cross-sections, and outlines and measurements of cross-sections are useful. The inflorescence, capsules and seeds should be well represented if possible. If the scape is a large one, cross or longitudinal sections of it and its branches, with bracts and flowers attached, could be taken. Some of the flowers should be split longitudinally and opened out in pressing.

The process of drying fleshy plants like Agaves can be much facilitated and improved by dipping their parts for a few seconds at a time in boiling water, and repeating the process till they are softened. Care should be taken not to injure the color of flowers by immersing them too long at a time.

Mr. C. G. Pringle, whose success with specimens is very marked, writes that he does not always scald the leaves, but that a week in press with two or three changes a day and exposure to the direct rays of the sun, suffices to dry the leaves of most species. He never scalds the flowers.

For all these reasons, it is very difficult for a student in the laboratory to decide upon the limits of a species or a variety, or to make satisfactory descriptions. An unsigned article* has recently appeared in one of our journals whose writer, while advocating the founding of a garden in Arizona for the cultivation of plants peculiar to our arid region, is led to say: "No group of American plants, with the exception, perhaps, of the Cacti, is more difficult to understand from specimens preserved in herbaria, and not much light is thrown upon these plants [Agaves], by the occasional isolated individuals which drag out a more or less miserable existence in the confinement of northern glass-houses. Labor expended in herbaria in the study of the plants we have mentioned, is practically thrown away, as it can only be partial, and never final."

Very little of our work can be regarded as complete or "final," and we should accomplish little if our efforts should cease for that reason. A desert garden would be a valuable acquisition. I can think of various questions I should like to see tested in a place where these plants could be systematically observed and compared under natural conditions, and where experiments could be well controlled. In the absence of such a garden, however, I think that much can be done in laboratory and field if good specimens are collected, and proper studies made.

We should be much assisted in forming correct ideas of the genus and the affinities of its species, if collectors would take habit photographs of the plants in their natural surroundings. Mr. C. G. Pringle, and Dr. T. E. Wilcox, have done valuable work of this sort.

When practicable, living plants should be sent to botanical gardens where they will receive care and study.

In this paper I have tried to bring together such information as I could gain concerning our Agaves from library, herbaria, conservatory and field, and to add what it was

* "An Arizona Agave." Garden and Forest, May 8, 1895.

possible to learn in a short time through correspondence and the examination of all available living material. Dr. Trelease has kindly arranged to have the plants illustrated in such a way that they can be readily recognized. I shall be very glad if my work may serve as some stimulus to further collection and observation.

The Agaves occupy a prominent place amongst the characteristic plants of the hot and arid regions of our continent. The genus contains a pretty distinctly marked group including the largest and tallest of our herbaceous plants. Their flowering stalks sometimes rise to the height of forty feet or even more, and their conspicuous inflorescence renders them objects of great picturesqueness.

They are much prized by all who take an interest in the cultivation of plants. Few conservatories or gardens are without them. They make a most effective decoration for lawns, terraces, rockwork and pleasure grounds. Their large size, symmetry of form, stately and elegant proportions were well characterized by Linnaeus when he applied to them the name "*Αγαυη'*," noble, admirable, wonderful.

By far the largest number of species have their homes in Mexico, Central America, and the Southwestern portions of the United States from Texas to California. Two or three forms are native to our Southern States, and a few perhaps to South America and the West Indies. A. Americana, the species most commonly seen in small collections, is native to the fertile soil of Opam in Southeastern Mexico, but it readily adapts itself to new localities. It has become naturalized in the Mediterranean region, in the West Indies and probably in Texas and Florida. Other species have become naturalized in Florida and the adjacent islands.

The thick fleshy leaves of Agaves generally have their broad bases imbricated over one another around a short axis, thus forming a compact tuft with comparatively little evaporating surface. The cuticle is adapted to resist transpiration. Roots and leaves contain large quantities of

mucilage, saponin and salts which hold water in solution with great tenacity, and enable the plants to survive through long protracted seasons of dryness incident to a land of almost perpetual sunshine. Like other plants with a well developed aqueous tissue, they may be justly compared to camels, the "ships of the desert."

Most species are armed with stout spines, marginal prickles, corneous margins, or dry fibrous filaments. These render efficient protection against the attacks of hungry and thirsty animals, who would gladly seize upon their juicy and nutrient substance.

Agaves usually grow slowly. In their natural habitats some attain maturity in three or four years, while others require ten to fifteen years or more. Taken from their homes and placed under new and strange conditions, they seldom make an effort to bloom. Although they respond to care, and grow into fine plants much prized in decoration, so rarely are their flowers seen that they have long been called "Century Plants," because of the old idea that they bloom once in a hundred years only.

When the period of inflorescence arrives, a great change is observed. The newer leaves are successively smaller and narrower; the central bud thickens, and after a season begins to shoot upwards with marvelous rapidity. What at first appear like narrow young leaves clustered around it, gradually become more and more separated by the elongating axis, and are seen to be bracts placed upon it at regular intervals.

Dr. Engelmann* gives a fine description, accompanied with illustrations, of the flowering of A. Shawii at the Missouri Botanical Garden (Plates 44 and 47.)

A plant here (Plates 62 and 63, Figs. 5, 6, 7), labeled A. horrida micracantha, commenced to send up a flower stalk early in November, 1894. Daily measurements of growth

* Transactions of St. Louis Academy, iii. 371. Collected writings, 314 to 320.

were made. For twenty days after November 16th, this averaged two and three-fourths inches per day. After that its average increase gradually lessened, and more of its strength was used in the development of the flower buds. Flowers began to open the first week in January, and the last ones opened the second week in February. The plant matured an abundance of fruit before the middle of June and the leaves were then seen to be rapidly dying off.

After the great expenditure of energy displayed in producing flowers and fruit, the vitality is usually exhausted. The plants generally send out suckers or offsets, and then quickly die and give place to the next generation. This, however, is not an invariable rule. The species bearing annual leaves, may bloom annually, and Nicholson's Dictionary of Gardening states that A. Sartorii does. A plant of A. Ghiesbrechtii which bloomed in this garden three years ago, but which formed no fruit, still shows no signs of decay. A. Engelmanni, named and described by Dr. Trelease,* bloomed here in 1890, and lived until the summer of 1894.

A plant here named A. heteracantha by Mr. Baker of Kew, was raised from seed sent to the Garden about seventeen years ago. This never suckers like our A. Lechuguilla, but is strongly caulescent. Its offsets or branches of the main stem crouch rather closely to the ground, giving a straggling effect to the whole. Many new buds are now starting also from the axils of older leaves. This plant bloomed here for the third time in January, 1892. It has a very healthy appearance and is now sending up flowering stalks from two of the side branches.

A correspondent of the Gardener's Chronicle † states in substance that mostly all of the forty-eight American Aloes that bloomed in the gardens of T. A. Dorrien Smith, Esq.,

* Third Annual Report, Missouri Botanical Garden, 1892, 167, Pl. 55, 56.

† June 1877, 820.

Tresco Abbey, Isles of Scilly, in 1875, were still living in 1877. One flowered in 1876. This had been damaged and had lost its central spike by being overgrown by a large Fuchsia. It afterwards threw up three small spikes from the axils of its lower leaves.

Other cases* of lateral inflorescence are noted. Dr. Goeppert in Regel's Gartenflora,† describes some interesting ones. A large Agave (in Botanical Garden of Löwen) produced a large terminal inflorescence, and in the following year five lateral ones, and finally in the third year an extraordinary number of flowering stems, some of them bearing only one flower. He further states that when the French landed in 1830 at Sidi Ferruh, they found the neighborhood of Algiers thickly studded with Agaves. In the summer of 1831, not one of these plants bloomed, and it having been determined to form a camp many of the soldiers amused themselves by beheading the Agaves. In 1832 all these multilated Agaves threw up flower spikes, and more than fifteen hundred were crowned with flowers at one time, affording a magnificent spectacle. When lateral flowering occurs, it often seems to be the result of an injury to the central axis which sends its strength into a side bud, making it in its turn a terminal bud.

The propagation of the Agaves is easy and rapid. Seeds are produced in great quantities and, under favoring conditions, readily germinate. The cotyledon is long and narrow and bears the seed-coat at its apex until fully matured. (Plate 63, Figs. 2, 3, 4.)

Many species while quite young also produce an abundance of suckers or offsets which frequently form a circle of progeny around the parent plant. In the Death Valley Expedition, near Mountain Springs, in the lower part of the piñon belt, Charleston Mountains, Nevada, a "tuft of A.

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* Lachaume, Revue Hort. 1876, 182; Gard. Chron. May, 1876, 696; S. B. Parish, Erythaea, 1893, 44; Gard. Chron. 1883, 370.

† Vol. xxvii. 1878, 307. Gard. Chron., Jan., 1879, 50.

Utahensis* was seen with forty-two well developed heads besides many smaller ones growing from a single root."

Dr. E. L. Greene† describes a remarkable case of abnormal flowering of A. applanata Parryi. "The mature central and parental member of a cluster of plants on coming into flower, had communicated its floriferous energy to all its offspring, great and small, and there were eight or ten of them, each of which bore at the same time its scape of flowers."

A number of species belonging to the Euagave section are viviparous. Young plants or bulbilli are produced on the branches of the scape in place of, or in connection with, the capsules. These give a queer appearance to the plant while they still remain attached. They eventually fall to the ground, take root, and grow into good plants.

On page 53, a plant labeled A. horrida micracantha, which bloomed at the Garden last winter, was spoken of. A few weeks after the flowering had ceased and while the abundant fruit was being rapidly matured, quite a large number of bulbilli appeared just below the apex of the scape, at about the point where the flowers had ceased to form. A similar development has been observed elsewhere upon a plant of the Littaea section.‡

Thus protected and defended, thus prepared in so many ways to propagate their species, the Agaves are seen to be well fitted to sustain life in the desolate barren mountains and superheated valleys to which they have been assigned. Their vitality is most wonderful. Plants are frequently taken up by the roots and kept for months with no water or care of any kind, and afterwards on being planted, show good growth.

Unfortunately, little is known in regard to the pollination of these plants. Bees and flies are seen upon them. Though some flowers of the species in bloom here last

* Contributions from the U. S. National Herbarium, iii. Nov. 29, 1893, 201.

† Erythaea, 1893. i, 52. ‡ Engelmann, Collected Writings, 308.

winter were pollinated artificially, most of the others also matured their fruit, and showed that the pollen from upper flowers must have done its work upon the stigmas of the lower ones.

Why the flowering stems of some Agaves should attain so great a height is not easily explained. I am told by residents of New Mexico that the red-polled sparrow and other birds are seen to visit the inflorescence of A. applanata Parryi. This species produces an enormous quantity of sweet nectar. If birds or high-flying insects assist in pollination, the task of finding the flowers would evidently be much facilitated by their commanding position.

The height doubtless assists in disseminating the seeds to a greater distance than would otherwise be possible. As the capsules open from above, the swaying of the poles must cause the seeds to be caught by the air currents as they are dislodged; being thin and flat they may be carried to a considerable distance beyond the circle of progeny formed by suckers, before reaching the ground.

It is stated that certain Agaves are hybridized* in cultivation. If this is readily accomplished, it can be inferred that similar instances may occur in a state of nature, and upon this basis, explanations may be made of some of the queer freaks and differences of form so often observed.

I have been able to secure but slight information in regard to the enemies of the Agave. They are injured by an insect (Scarabaeus†) called Maax (pronounced maash) by the Mayas. This bores through the center of the plant and destroys the softer parts. In cultivation the natives hunt this insect daily with pointed sticks and fill up the holes with pebbles and soil. Domestic animals, especially cattle, hogs and goats, are very fond of these plants when young, and will even chew the mature leaves for their juice.‡

* Gard. Chron. April, 1877, 438.

† Agric. Report. 1869, 257. Riley, Insect Life, 1890 and 1891, 432.

‡ Agric. Report, 1869.

Previous to the heavy rains and floods in our South-western territory during the past summer very little rain had fallen for three years. The beds of most streams were perfectly dry and even the Rio Grande carried very little water. Scarcely a vestige of green vegetation was to be seen except in the cañons far up in the mountains. We saw the cattle lying upon the hills dead and dying. Those which survived had done so only through the most terrible straits. Many of them in their desperation were glad to feed upon even the older Agaves and the Cacti; and I was told that it was no uncommon thing to find their tongues pierced through and through with a network of the terrible spines.

ECONOMIC USES.

From time immemorial these plants have been utilized in various ways. The Aztecs showed their appreciation by reverencing "Mescal" or the Agave, as one of their gods under the name of Quetzalcoatl.*

The Aztecs, Mayas and other inhabitants of the country have made saddle-cloths, sacks, ropes and other articles from the fibers. The softer parts have afforded them important articles of food and drink and a soapy liquid for washing. The flowering stalks made handles for their lances, poles for fishing, and walls for their houses. Of the central shoot† of the Mescal the Apaches made their fiddles (Captain Bourke unfortunately is not willing to indorse the music). The end-spine with attached filament served as needle and thread. When General Crook went in March, 1886, to treat with Geronimo, in the Chiricahuas, he found him and his Indian warriors in a rancheria whose buildings were constructed of Agave and Yucca stalks.‡

* "On the Border with Crook." Captain John G. Bourke. 1891. 10.

† Captain John G. Bourke. Folk Foods of the Rio Grande Valley and Northern Mexico, in American Folk Lore, April, 1895.

‡ On the Border with Crook. Captain John G. Bourke. 476.

Professor W. J. McGee, who has just visited the savage Siri tribe on Tiburon island in the Gulf of California, obtained from them necklaces made of pretty seeds strung on maguay fibers. Humboldt tells of a bridge at Quito, having a span of one hundred and thirty feet, made of ropes of Agave fiber four inches in diameter. It is said that Agave juice is mixed with wall-plaster and used as an insecticide to keep out the white ants which are so destructive in tropical countries. The spiny leaves of the Agave have caused it to be used very effectively as a hedge plant in the Mediterranean region. Its leaves are sometimes cut in slices and used as fodder for cattle. Its flower-stem dried is used to make excellent razor strops* and scouring material.

In A. Lechuguilla, the connective tissue, according to Dr. Havard† "constitutes about 40 per cent.of the green leaf; when dried it is a white or yellowish mucilaginous powder, which possesses remarkable cleansing properties, principally due to the presence of saponin. Its composition is very probably analogous to that of Yucca baccata. Rubbed with water, it foams and lathers, answering the purposes of good soap, without, owing to its freedom from alkali, its disadvantages. It imparts a smooth and satiny appearance to the skin, and is used successfully in removing stains from the most delicate fabrics. It tends rather to set than to displace colors, and articles likely to fade may be washed with it in safety. It is also an excellent wash for the scalp and hair, leaving the latter soft and glossy. If the powder could be compressed into small cakes or tablets, it would doubtless become an important article of trade." The A. Schottii of Southern Arizona is also extensively used as an amole, or soap-producing plant. The Mexicans and Indians sell it in the towns for this purpose.

Under favorable circumstances the A. Americana, or

* Peter Henderson, Handbook of Plants. 1881.
† Proceedings of National Museum. 1885. 518.

Maguay, the species most generally known as the Century Plant, will bloom at ten years of age. At the time it is ready to send up its flowering stalk, a most remarkable upward flow of sap takes place to meet the new demands. The liquor, called "agua de miel," or honey-water, is very sweet, and the Mexicans and Indians find it much to their taste. They cut out the central bud and leaves, and insert a long, cylindrical gourd to receive the liquor. Some plants produce an average of two gallons per day, and keep up the supply for months.

Pulque, a universal drink in Mexico, is made by collecting considerable quantities of the "miel" in vats made of rawhide, and causing it to ferment. This liquor, which at first was greenish or yellow, is now white and appears much like half-turned buttermilk. It has a strong yeasty odor. Though it is said to acquire a strong taste from its reservoir, foreigners, as well as the Mexicans, acquire a taste for it, and it has become an article of commerce. It is said to be cool, refreshing, palatable and nutritious. The A. Mexicana is also used in the manufacture of pulque. Mr. Baker* states that the A. atrovirens is the species especially used. I find the A. Americana most frequently mentioned. Mr. Dodge† states that it is made from any species with a crown sufficiently large to form a receiving reservoir for the liquor as it exudes.

From the pulque, by a process of distillation carried on in their pulquerias, the Mexicans manufacture a fiery and intoxicating liquor which they call "aguardiente de maguay," "mescal," or "mescal tequile," to distinguish it from "mescal sotol," made more cheaply from Dasylirion. Both pulque and mescal are regularly peddled in the streets in receptacles made of pig-skins, which will hold from twenty to thirty gallons. They may always be obtained in the pulquerias or cantinas (saloons), where the walls are

* Amaryllideae, 174.

† Report of Sisal Hemp Culture. Fiber Investigations. 1891. 46.

covered with highly-colored representations of the "Sacred Heart,*" "the Good Shepherd," etc., to keep the mind from being inflamed with thoughts of strife and blood. A pinch of salt, or flavoring of orange or lemon peel, is usually taken with the mescal, to remove the fiery taste.

Considered from the stand-point of food, certain species of Agaves growing in our Southwestern States and Territories are esteemed great delicacies by the Indians. These do not have so great a flow of sap as the Maguay plants and are further distinguished from them by having shorter and relatively broader leaves. Several species are used, but they are quite indiscriminately called "Mescal," as is also the jelly-like mass prepared from them as well as the intoxicating liquor fermented and distilled from its juice.

The species most eagerly sought after by the Apaches are A. Palmeri, and A. applanata Parryi. Mr. Coville† gives a very interesting account of the use of even the small A. Utahensis by the Panamint Indians. The process of cooking seems to be much the same in all cases. A large pit is prepared and lined carefully with small smooth stones. A fire is kept up within the pit until the stones are thoroughly heated, and then raked out leaving the pit ready for use. The plants are trimmed until nothing is left except the hearts, which consist of the sweet juicy stalks and young leaves. These are heaped on the hot stones in the pit, covered over with grass and earth and left to steam for two or three days. By this time all except the fibrous tissue is reduced to a jelly-like mass, very palatable and nutritious. Captain Bourke‡ states that the Apaches put in the pit a plug made of the stalk of the plant. This they pull out as a test, and if the end of the plug is cooked the squaws decide that the whole mass is.

Dr. Parry writes in a letter to Dr. Engelmann, that this

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* Captain J. G. Bourke. Folk Foods of Rio Grande Valley and Northern Mexico.

† Panamint Indians of California. American Anthropologist, v. 1892.

‡ On the Border with Crook. p. 200.

cooked "Mescal" is much like half-made molasses candy into which oakum has been dipped. Professor Toumey writes that it has a sweet and not disagreeable taste, but that it has a smoky flavor arising from the method of cooking.

By fermenting and distilling its juice the Indians make their drink called "Mescal," which is very intoxicating, casting all records attributed to "Jersey lightning," most completely in the shade. Professor Toumey writes a very interesting letter in regard to finding a party of Pepago Indians in May, 1894, encamped in the Catalina mountains, fourteen miles north of Tucson, for the purpose of making "Mescal" from A. Palmeri. He says the camp had a rank odor from the fermentation of the cooked mescal thrown about on all sides. On taking the mescal from the pit, it was put into large Indian baskets, and the women squatted down on the ground and stripped the epidermis and as many of the fibro-vascular bundles as possible from the cooked leaves. The prepared material was then spread on the ground or on blankets to dry. Large quantities of mescal are made by the Indians each spring, and carried back with them to their reservations, where it forms an important factor in their food supply throughout the year.

Dr. Havard* says that the mescal pits are still seen in the Guadalupe Mountains, Texas, and that "cooking develops a large proportion of grape sugar which exists in combination with citric acid as a citro-glucosid. It is set free by exposure to heat or by application of cold water." He also says that the young leaves yield by pressure a juice which "is slightly acidulous, laxative and diuretic, therefore a good antiscorbutic."

Professor Toumey's letter already referred to goes on to say that the epidermis and fibers, separated by the squaws from the edible portion of the mescal, are not thrown away, but are taken by the men, thoroughly washed and

* Proceedings U. S. National Museum. 1885, viii. 519.

cleansed, and the fibers well separated, so that they can be made into ropes. Each man takes a quantity of these fibers, and begins to twist. When the strands are of sufficient length, they are tied to trees, and the men backing away from the trees continue to add fibers and to twist. Their work is assisted by small sticks, about a foot long and larger and heavier at one end. By fastening the small end to the rope close to the hand, the twist made is given a greater force by the motion of the heavy end in flying round and round. When the ropes are of the required length, the loose ends are pegged to the ground and left for several days to dry. Professor Toumey writes that hundreds of these ropes were staked out in the camp that he visited.

Of the Agaves native to the United States, the A. Lechuguilla produces the well-known Ixtli, or Tampico fiber, renowned for its great strength and durability. The fiber is coarse and short, but very tough. It is used in Texas and Northern Mexico for making sacks to convey ore from the mines, for coarse ropes, brushes, etc. In extracting the fiber, the spines and horny margins are removed, the leaves are crushed or scraped with knives by hand, and then after one or two days' exposure to the sun, the soft connective tissue is washed out, and the fibers collected. Machinery is now being employed in some places for obtaining this fiber.

The patient and industrious Mayas early recognized the value of fibers for domestic purposes, and it can probably be proved that they made of fiber an article of export. From generation to generation the culture of the best fiber-producing species has been their chief industry, and it is to-day a never failing source of wealth to the peninsula of Yucatan. Their culture has developed several varieties. A. rigida elongata, called Sacci or Saqui, by the Indians, is their chief dependence. Its fiber is abundant, white and flexible.

Dr. Perrine, when American Consul to Campeachy,

strongly advocated* the introduction of tropical plants in Southern Florida. As a result of his patriotic and laborious efforts, a number of species were planted at Key West, and on the Perrine Grant, Biscayne Bay, in 1836, 1837, and succeeding years. The A. rigida sisalana, or Yaxci (pronounced Yaashki) has taken most kindly to its new home. It forms dense thickets in many places, and seems to have become fully naturalized below the frost line in Florida and the adjacent islands. There seems to be every reason for believing that the efforts now being made in Florida and the Bahamas in its cultivation, and in improving methods for the extraction of its fiber, may result in adding greatly to the wealth of both places. Its leaf produces less fiber than the Yucatan form, but it "excels in fineness, softness, flexibility and luster."

CLASSIFICATION AND STUDY OF SPECIES.

The genus Agave may be characterized as being acaulescent or shortly caulescent, having leaves in a close rosulate tuft, with broad clasping bases, usually fleshy, and more or less rigid, traversed by strong, elastic, longitudinal fibers, and generally armed with terminal and lateral spines; scape bracteate; inflorescence subspicate or paniculate; flowers articulated on short, persistent pedicels, bearing one or two bracts, usually brownish or greenish yellow, proterandrous; perianth narrowly funnel-shaped to campanulate, with six nearly equal oblong or linear segments; tube straight or somewhat curved; filaments filiform, folded in the bud, in the flower usually extending considerably beyond the segments; anthers large, versatile, introrse; ovary oblong to cylindrical; septal glands large, and in many species secreting a remarkable quantity of nectar; style at last usually equaling or exceeding the stamens, filiform, slightly clavate, with three commissural

* Senate Document No. 300, March, 1838. Dr. Schott, Agricultural Report. 1869. 257.

stigmas, which slightly open or broadly expand at maturity; fruit a dry, erect, globose to cylindrical capsule, loculicidally three-celled, having two rows of numerous, thin, black seeds in each cell, and generally opening in upper part only; embryo filiform.

The inferior ovary* gives the strongest reason for classing this genus with the Amaryllidaceae. Its capsules, numerous discoid seeds, and elongated cotyledons show affinities with Liliaceae. Within the Amaryllidaceae, it is closely allied to Furcraeae.

The best basis for a classification of the Agaves lies in the fundamental differences in the forms of inflorescence, accompanied, as they are, by group differences in the structure and forms of the leaves. The sections recognized by Dr. Engelmann, — *Singuliflorae*, *Geminiflorae*, *Paniculatae*, may be very technically described as having flowers usually subspicate and solitary; flowers usually subspicate, in pairs; and flowers paniculate. As these are subgeneric

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* Leichtlinia protuberans Ross, A. protuberans Engelm., has been placed between the genera Polianthes and Agave, on account of its conical ovary protruding into the perianth.

On July 29th, I collected a monstrous inflorescence of A. applanata Parryi, in the mountains above Pleasant Valley, a few miles from Fort Bayard. The top of the scape had been broken by some accident, and the plant had made an effort to produce flowers on a low branch of the inflorescence. These flowers were in a thick mass close to the main axis. All were imperfect or distorted. Some were grown together. The segments in nearly all cases were greatly broadened and frequently thickened. The filaments also were broad and in some cases showed a distinct reversion to the petaloid character. In some flowers it was difficult to tell whether a certain organ represented a segment or a filament, but in the larger and better developed flowers, there was usually an equal number of each, and this number varied from six to five, four, three, and even two. In one large flower the style was irregularly four-lobed, and the stigma, three-lobed, one lobe being much larger than the other two. The ovary was usually represented by a short thick mass of tissue with little or no differentiation. Mr. Webber writes me of finding a monstrous Agave flower upon a plant of what I suppose was A. rigida sisalana. This flower had stamens and pistils perfectly developed, but was without any ovary differentiation, and was found growing from a cluster of leaves of the bulb.

distinctions, however, perhaps it is well to make use of the substantive names used by Mr. Baker for these divisions,— MANFREDA (Salisb.), LITTAEA (Tagl.), EUAGAVE (Baker), and also to use the terms employed by him to designate the groups formed on leaf characters, though so far as they apply to our United States species, I cannot follow him strictly in their application.

It must constantly be borne in mind that the variability of species within the genus is so great that any attempt to draw precise lines in classification results in failure. A. Lechuguilla has been found with flowers in clusters* of from three to ten instead of in pairs. Both with reference to leaf and floral characters, A. Utahensis might almost as well be grouped with Euagave as with Littaea. Some six or eight plants of A. brunnea Watson, of the Manfreda section, bloomed at the Garden last June. Most of these plants bore single flowers in the axils of their bracts. One plant of a vigorous growth, showed at two points a second flower in the axil of the lateral bractlet. One of these was sessile and the other pedicellate, as shown in plate 63, figs. 8, 9. Dr. Engelmann notes a case † in which a plant of A. Virginica produced secondary flowers year after year. In his plant a third flower sometimes appeared. In leaf characters many instances could be cited of departure from the normal form. A. parviflora of the group Filiferae has been considered unique in bearing teeth as well as filaments, but the Garden has recently received a specimen of A. Schottii from Professor Toumey which shows the same peculiarity.

I subjoin the general schemes of classification adopted by Terraciano and Baker.

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* Dr. Engelmann, Gard. Chron. Jan., 1883, 48.— A. heteracantha, Engelm.

† Collected Writings, 303.

TERRACIANO.

Conspectus sectionum ac subsectionum.

Agave.

I. Aplagave, Terr.
- A) Singuliflorae, Engelm.
  - a) Herbaceae, Terr.
  - b) Spicatae, Terr.
  - c) Canaliculatae, Terr.
- B) Geminiflorae, Engelm.
  - d) Emarginatae, Terr.
    - I.
      1. Yuccaefoliae, Baker.
      2. Striatae, Terr.
      3. Filiferae, Baker.
    - II.
      4. Attenuatae, Baker.
      5. Aloideae, Terr.
      6. Aculeatae, Terr.
  - e) Marginatae, Baker.

II. Cladagave, Terr.
- C) Paniculiflorae, Terr.
  - f) Americanae, Terr.
    - 7. Integrifoliae, Baker.
    - 8. Americanae, Baker.
    - 9. Rigidae, Terr.
    - 10. Viviparae, Baker.
  - g) Submarginatae, Baker.

BAKER.

Key to genera founded on inflorescence:—

Euagave, Baker. Fls. in clusters at ends of branches of deltoid thyrsoid panicle

Littaea (Tagl.). Fls in pairs, in dense cylindrical subspicate inflor.

Manfreda (Salisb.). Fls solitary in simple, lax, subspicate raceme or spike

Key to Series and Groups founded on the shape, size and texture of the leaves:—

Series I. Coriaceo-carnosae. Lvs persistent, rigid, thick, not flexible. End-spine large & pungent!

Group 1. Filiferae. Edge of leaf splitting off into distinct threads.

2. Marginatae. Edge of leaf w/ continuous toothed horny border all wa

3. Submarginatae. Continuous toothed horny border upper 1/2 or 1/3.

4. Americanae. No horny border below top. Teeth large, repand betw

5. Rigidae. Same but teeth small & edge not repand betw.

6. Striatae. Leaf edge minutely serrulate; surfaces strongly ribbed

7. Integrifoliae. Leaf edge entire, surface not ribbed

Series II. Carnoso-coriaceae.
Group 8. Geminiflorae.
9. Aloideae.
10. Serrulatae.
11. Attenuatae.
Series III. Flexiles.
Group 12. Viviparae.
13. Yuccaefoliae.
Series IV. Herbaceae.

SYNOPSIS OF UNITED STATES SPECIES.

* Acaulescent; perennial, from stout, evident, sometimes elongated rootstocks; roots fleshy; leaves loosely spreading or ascending, soft, thin, annual, without horny spines; flowers normally subspicate and solitary; stigmatic lobes spreading.— MANFREDA (Salisb.). *Herbaceae* (Baker); *Singuliflorae* (Engelm.).

+ Stamens inserted near base of tube; leaves usually green.

A. VIRGINICA L.— Leaves six to fifteen, green, sometimes marked with purple striae, very rarely spotted, 15 to 45 cm. long, 2 to 5 cm. wide, lanceolate to oblong or spatulate, concave, a little flexuous; apex ending in a sharply narrowed herbaceous point; margin irregularly and obscurely serrate; scape slender, 9 to 18 dm. long, upper 3 to 5 dm. or more floriferous; lowest bracts almost as long as the leaves, upper ones much narrower and shorter; flowers shortly pedicelled, greenish or brownish yellow, very fragrant, 25 to 37 mm. long; ovary oblong; tube narrowly funnel-shaped; segments linear-oblong, 10 to 12 mm. long; filaments much thickened upwards, and extending 20 to 25 mm. beyond segments; anthers 12 mm. long; capsule globose, 15 to 20 mm. long, including short stipe and beak, and nearly as wide; seeds 4 to 6 mm. in longest diameter. — Sp. Pl. (1753) 323; Jacobi, Monogr. (1864) 174; Engelm. Trans. St. Louis Acad. iii. (1875) 301, Collected Writings, 306; Terr. Monogr. (1885) 13; Baker, Handbook of the Amaryllideae, (1888) 197. — Icones: Bot. Mag. ser. 1, xxix. pl. 1157; Jacquin, Icones Plant-

arum, ii. pl. 378; Lamarck, Encyclop. Method. i. pl. 235, fig. 2.— Maryland southward to Florida, westward to Indiana, Tennessee, Missouri and Texas. Mr. Nealley reports it as abundant around Corpus Christi, Texas.— Plates 26 and 27.

Var. TIGRINA Engelm.— Stout, with large purple-spotted leaves, and depressed globose capsules.— Trans. St. Louis Acad. iii. 302, Collected Writings, 306.— Bluffton, South Carolina, Dr. Mellichamp. In one spot only, — a tongue of partly brackish land, extending out into the salt mud and marsh under dwarfed live oaks, cassine and saw palmetto, on the decayed shells mixed with sand and earth of what appears to be an Indian oyster-heap.* This form, discovered by Dr. Mellichamp twenty years ago, still persists in the locality indicated. Plants sent to the Garden by Dr. Mellichamp early last spring began to send up new leaves very soon. These were green at first but began to develop purple spots in May. Plate 63, Fig. 1, shows the plant in its early growth.

Dr. Engelmann† mentions a plant which year after year produced second and sometimes third flowers on the pedicels. In the Engelmann and Gray herbaria there are specimens of a monstrous form sent by Dr. Short from the bank of Kentucky River near Elk Lick in 1831, 1833, and 1834. These plants have very large broad leaves; their flowers are thick and enlarged, with nearly cylindrical tubes, and their enlarged filaments cohere slightly by the edges, giving the effect of another much elongated tube. Flowers collected by Mr. Bush in Shannon County, Missouri, have filaments bent forward and even a little twisted at base.

The fragrance of the flowers is very persistent and was observed by Miss Johnson while making the plate from

* Dr. Mellichamp, in letter to Dr. Engelmann, Jan. 22d, 1876.

† Trans. St. Louis Acad. iii. 296. Coll. Writings, 303.

herbarium material. The name Rattlesnake Master is applied to this plant.

+- +- Stamens inserted in upper part of tube; leaves usually spotted; Texan.

++ Stigmatic lobes rounded.

A. VARIEGATA Jacobi.— Leaves lanceolate, green, spotted with brown; teeth obscure but sharper than those of A. Virginica, and turned upwards; scape 9 to 15 dm. long, laxly flowered; flowers 38 mm. long; lobes about equal to tube; stamens inserted at two-thirds or three-fourths of the distance up the tube, 5 cm. long; anthers 8 mm. long; capsule oblong-cuspidate, 15 to 22 mm. long; seeds oblique.— Monogr. (1864) 180; Engelm. Trans. St. Louis Acad. iii. 303, Collected Writings, 306.— Lower Rio Grande, near Mier and Metamoras, Dr. J. Gregg, May, 1847.

++ ++ Stigmatic lobes emarginate.

A. MACULATA Regel?—Leaves fleshy, recurved, concave or channeled throughout their entire length, 15 to 30 cm. long, 10 to 20 mm. wide, narrowly lanceolate, tapering to apex, light green, glaucous, mostly spotted with dark green or brown; margin usually transparent, with evident, irregular, small cartilaginous teeth; scape 9 to 20 dm. high, the upper 2 or 3 dm. floriferous; bracts ovate to linear-lanceolate at base of scape, and more or less denticulate, the upper ones gradually reduced, entire; flowers nearly sessile, purplish-green to white, fragrant, 30 to 50 mm. long; segments suberect and mostly nearly as long as the stamens, or less commonly widely recurving, oblong, 10 to 18 mm. long, 5 mm. wide; filaments inserted at base of lobes; anthers 8 to 16 mm. long; stigma velvety at tip; capsule 20 to 25 mm. long, including stipe and beak, a little longer than broad, its walls thicker than in A. Virginica.— Ind. Sem. Hort. Petrop. 1856, 16, Annot. Bot., Ann. des Sci. Nat. vii. (1856) 74, Gartenflora,

1857, 158; Baker, Amaryllideae, 196; Terr. Monogr. 11; Engelm. Bot. Mex. Bound. (1858), 214. *A. maculosa* Engelm. Trans. St. Louis Acad. iii. 301, Coll. Writings, 305. — Icones: Hook. Bot. Mag. ser. 3, xv. pl. 5122; Fenzi, Gard. Chron. 1872, 1194, fig. 273. — Southern Texas. — Plate 28.

Represented by two forms, of like distribution, of which the more common has the perianth tube longer than the suberect segments which nearly conceal the anthers; the bracts are elongated, and the leaves long, robust and slightly denticulate. The other form, which is the variety *brevituba* of Engelmann, Trans. St. Louis Acad. iii. (1875) 301, Coll. Writings, 305, has the tube about equal to the segments, which are frequently recurved. This exposes the longer anthers and filaments. The bracts are broader and shorter, and the leaves are short and narrow.

This is an exceedingly variable species. I have placed in it all specimens of the Manfreda group in Southern Texas which have emarginate lobes to the stigma. I have followed Baker in employing for it Regel's name, although the emargination of the stigma is not mentioned in the original description of A. maculata. The filaments are there described as being long-exserted, and the species is said by Regel to be related to A. rubescens, Salm-Dyck. In the figure of Hooker cited, the emargination of the stigmatic lobes is scarcely more than suggested, but in that of Fenzi, it corresponds well with the typical form of our species. I find a specimen in the Gray herbarium, collected by Dr. Palmer, with narrow strongly denticulate leaves; flowers 35 mm. long, segments 10 to 12 mm. long, and filaments 15 to 25 mm. long. These filaments protrude beyond the segments. The stigmatic lobes are emarginate in some of the flowers. It is possible that collectors will find Regel's plant, and perhaps transitions between the two, in Northern Mexico. Perhaps our plant may prove to be a variety of the other.

Specimens examined: — Mier, amongst Mezquit trees,

Dr. Wislizenus, No. 373, May 31, 1847; Cultivated at Missouri Botanical Garden, July, 1861; July, 1879; Otto Ludwig, San Antonio, 1877; Dr. V. Havard, Eagle Pass, 1883; Albert Turpe, 1893; A. A. Heller, June, 1894, Corpus Christi; Dr. Schott, Rio Bravo del Norte, Lizard Hills, April, 1854, somewhat intermediate in form. —Var. *brevituba*:— Wright, No. 1905, below El Paso; G. C. Nealley, 1887, 1895; with protruding filaments, Dr. Edward Palmer, 105 miles southeast of San Antonio, September, 1879, No. 1306.

Dr. Schott in a note, April, 1854, states that the leaves of A. maculata are recommended by the Mexicans as an efficient remedy against the bites of rattlesnakes. Mr. A. A. Heller makes a very similar statement.

* * Acaulescent; perennial, from scarcely distinguishable rootstock; roots fibrous, fleshy; leaves ascending, turned to one side, relatively narrow, thick, fleshy, fibrous, persistent; end-spine horny; flowers normally in pairs, forming a dense subspicate inflorescence.— LITTAEA (Tagl.). *Geminiflorae* (Engelm.).

\+ Leaf with a filiferous margin; marked with white lines made by delicate layers of epidermis left by margins of adjoining leaves in separating from the bud.— FILIFERAE (Baker).

\+\+ Marginal fibers delicate.

A. SCHOTTII Engelm.— Leaves 15 to 35 cm. long, 6 to 12 mm. broad, convex on lower side; end-spine 6 to 10 mm. long, slender, terete, brownish-gray; margin of base membranous, sometimes (in variety) serrulate; scape 15 to 20 dm. high; bracts very slender; flowers pale yellow with agreeable fragrance; 30 to 40 mm. long; perianth infundibular; lobes linear to oblong, or short and broad; filaments inserted a little above the middle of the tube; anthers 7 to 12 mm. long; ovary broad; capsules nearly globular or oblong, 10 to 15 or 25 mm. long, including stipe.— Trans. St. Louis Acad. iii. 305, Collected Writings, 307; Baker, Handbook of the Amaryllideae, 166. *A. geminiflora* var. *Sonorae* Torrey, Bot. of the Boundary (1858), 214. *A. geminiflora* var. *filifera* Terr. Monogr.

18.—Very abundant on the mountains of Southern Arizona, from the Santa Catalina to the Chuncahus at an elevation of about 5,000 feet. — Plate 29.

Specimens examined: — Dr. A. Schott's original specimens from Sierra del pajarito, VII., 1855; No. 1433 of Emory's Expedition, 1873; J. G. Lemmon and wife, April and May, 1880 and 1881; C. G. Pringle, Southern Mountains, 1881; Rincon Mountains, June, 1884; Santa Catalina Mountains, 1882; J. W. Toumey, Santa Catalina and Rincon Mountains, 1894.

Var. SERRULATA.— Of distinctly smaller habit; leaves narrower and shorter; leaf bases narrower, serrulate and slightly undulate; end-spine shorter; inflorescence more compact; perianth apparently broader at base; lobes very short and broad; anthers much smaller; filaments inserted at a greater distance below segments, longer; lobes of stigma fringed; capsules smaller, thinner, more persistent.— Collected in the Rincon Mountains, July, 1894, by Professor J. W. Toumey, of the University of Arizona, who states that he finds it to occur further south than the typical form.— Plate 29.

A specimen of A. Schottii collected by Mr. Pringle on "dry, rocky slopes of Southern Mountains," 1880, has capsules with much elongated beaks. Another specimen of Mr. Pringle's from the Rincon Mountains, June 19th, 1884, has groups of three and four flowers in the axils of the bracts.

Professor Tourmey writes that this species so thickly covers large areas miles in extent on the southern slope of the Santa Catalina Mountains that it is almost impossible to travel over it. The variety is not found in this locality. This plant is the amole of Arizona, and is sold by Mexicans and Indians in the streets of Tucson (Professor Toumey).

↔ ↔ Marginal fibers short and stout.

A. PARVIFLORA Torrey.— Plants very small, forming low rosettes; leaves thick, 5 to 10 cm. long, 1 cm. wide,

linear-lanceolate from a broad, deltoid base; end-spine slender, terete; marginal fibers few; base of leaf bordered with minute, cartilaginous teeth; scape 12 to 15 dm. high, slender; bracts very narrow with a broad base; flowers in twos or fours, small, 12 mm. long; perianth 8 mm. long; filaments inserted in lower part of tube, a little longer than perianth; capsule globular or ovoid, more or less cuspidate, 9 to 12 mm. long, 9 to 10 mm. broad; seeds dull, 2.5 mm. wide. Professor Toumey found well-developed seeds on August 20th.— Botany of Mexican Boundary (1858), 214; Engelm. Trans. St. Louis Acad. iii. 306, Collected Writings, 307; Terr. Monogr. 18; Baker, Amaryllideae, 166. Dr. Trelease in Fifth Report of the Garden, page 164, speaks of the rediscovery of this interesting plant by Professor Toumey in the Pinal Mountains, and makes critical notes in comparison. His plate is reproduced for this paper by his permission.— Mountains of Arizona, at head waters of the Salt and Gila Rivers, in the Pinal Mountains, at an elevation of about 7,000 feet (Professor J. W. Toumey), and near Chihuahua, Mexico.— Plate 30.

Specimens examined:— Original Schott specimens in Engelmann, Torrey and National herbaria, from Sierras of Pimeria alta, Arizona, July, 1855; J. W. Toumey, July, 1893; also specimens in Engelmann, Gray and Columbia College herbaria from "dry, porphyritic hills," near Chihuahua, found by Mr. C. G. Pringle in fruit, September 6, 1888. These Mexican specimens have longer and slightly narrower leaves, but agreeing with the Toumey specimen in being concave on the upper side. Their flowers are much longer than those from Arizona. The capsules are conically pointed above, and their globular form is similar to that of the Schott specimens.

Professor Toumey writes that A. parviflora propagates profusely by numerous suckers. Seeds from his capsules have developed into plants 5 cm. high, and from 8 to 10 cm. in diameter. Their pretty little rosettes bear dark green leaves with reddish-brown end-spines. After loosening

from the central bud, an extremely delicate white margin soon fluffs away, and the new epidermis below bears tiny little teeth from apex to base. A further development results in the formation of marginal threads on the upper portion of leaf, which eventually split off, while the teeth persist on the thin membranous margin of the base.

+ + Leaf with a continuous, toothed, horny margin from apex to base.— MARGINATAE (Baker).

A. LECHUGUILLA Torrey.— Leaves about 10 to 15, thick, concave above, rounded below, usually 20 to 35 cm. long, 2 to 3.5 cm. wide, others much larger, 5 cm. wide and sometimes 60 cm. long, narrowed above a very broad base, and after widening slightly, maintaining nearly parallel edges for some distance, and gradually tapering above, deep green with many interrupted darker lines on lower side, and less distinct ones on upper side when young; end-spine channeled, 18 to 40 mm. long, extending downwards to a point on the back of leaf; margin rather broad; teeth commencing at a considerable distance below apex, largest towards middle of leaf, 5 to 10 mm. long, rather distant, stout, usually strongly reflexed, sometimes flexuous; color of end-spine, margin and prickles, brown, soon turning to gray; margin and prickles at last splitting off, and falling away in pieces or entirely, but usually leaving a part attached to end-spine; scape slender, 18 to 40 dm. high; bracts 50 mm. long below, 10 to 12 mm. above, deciduous; flowers sometimes in clusters of three to several, and variable in size, (fresh) from 30 to 40 mm. long above base of ovary; perianth spreading, campanulate, greenish or yellowish white, sometimes deeply tinged partly or completely with purple; tube 2 to 3 mm., lobes 15 to 18 mm. long; filaments purple, inserted at base of lobes, 35 mm. long; anthers 13 to 16 mm. long; style slightly shorter than filaments; capsules ovoid or oblong, 15 to 35 mm. long; seeds smooth, shining, 3 to 4 mm. in longest diameter.— Bot. of the Boundary (1858), 213. *A. heter-*

+. l. = Mountains near El Paso along the R. G. downward

acantha Zucc. Acta Acad. Leop.-Carol. xvi. 675; Engelm. Trans. St. Louis Acad. iii. 306, Collected Writings, 308; Baker, Amaryllideae, 168. *A. Poselgerii* Terr. Monogr. 32.— Abundant on the limestone highlands of West Texas, and along the Rio Grande, as far east as Presidio, extending into Mexico and New Mexico. Mr. Nealley reports the Devil's river as the eastern limit.— Plate 31.— By error, the specific name was originally printed *Lecheguilla*.

Specimens examined:—From Mr. C. Wright, Nos. 1907 (1851), 682 (1849), 1432 (1852), Mexican Boundary Survey; Dr. E. Palmer, 1878; O. Meusebach, Jan., 1880; Dr. V. Havard, June and Sept., 1880, 1881, Guadalupe Mts., El Paso, and Presidio; J. G. Lemmon, Organ Mts., May 18, 1851; G. R. Vasey, El Paso, 1880, 1881; Shaw's Garden, July, 1884; W. A. Evans, El Paso, June, 1891; Lieut. Emory's Second Mex. Bound. Survey, 213.

The flowers I observed in Texas did not open their anthers upon first expanding. The anthers were of a salmon tint which marked a contrast with the lower ones a day older, which showed a bright yellow coloring, caused by the dehiscence of the cells, and discharge of the pollen. I saw many plants in Texas showing a tendency towards a paniculate inflorescence, and Dr. Engelmann in Gard. Chron. June, 1883, gives a special description of specimens collected by Dr. Havard. A figure is given showing a cluster of ten capsules.

A pest of the arid mesas and limestone cliffs of West Texas. The parenchyma of leaves and root furnish large quantities of amole valuable for cleansing purposes.* Its fiber, called Tampico, Ixtle, or Ystle, is very valuable† where strength and durability are required.

Though this plant certainly shows affinities with A. heteracantha Zucc. and A. Poselgerii Salm-Dyck, it differs from them in having a more stiffly sub-erect and one-sided

* Dr. Havard. Proceedings of U. S. National Museum, 1885, 518. Page 59 of this paper.

† Dr. Parry, Bot. of Bound. 11; Dr. Havard, l. c.; Kew Bull. Dec., 1887. Page 63 of this paper.

habit and in never developing a broad pale band down the face of the leaf. The group to which all these and a number of related forms belong, should receive careful study and comparison. Our plant may prove to be a variety.

+-+-+Leaf with a toothed, horny margin, decurrent for some distance below end-spine. — SUBMARGINATAE (Baker).

A. UTAHENSIS Engelm.— Suberect, compact; leaves linear-lanceolate, concave, rigid, fleshy, glaucous, 12 to 17 cm. long, 2 to 2.5 cm. wide, or larger, not contracted above the broad base; terminal spine 20 to 35 cm. long, stout, channeled, gray, with brown base, slightly decurrent; margin sometimes repand; prickles 1.5 to 2 mm. long, deltoid above, very minute and close-set below; scape 15 to 24 dm. high, straight or flexuous; upper 3 to 6 dm. floriferous; panicle narrow; bracts very slender; pedicels once or twice forked; flowers in 2's or 4's, sometimes in 6's, 22 to 25 mm. long, yellow, with a very pungent and fragrant odor; perianth about as long as ovary, lobes cut nearly to its base; filaments inserted a little below the middle of the broadly funnel-shaped tube, 15 to 18 mm. long; capsules ovoid, cuspidate, 2 to 3 cm. long above the stipe, which measures about 4 mm.; seeds 4 mm. in greatest diameter, marked with flat punctate areoles.— Sereno Watson's Botany of 40th Parallel (1871), 497; Trans. St. Louis Acad. iii. 308, Collected Writings, 308; Baker, Amaryllideae, 177. *A. Haynaldi* Tod. var. *Utahensis* Terr. Monogr. 28.— Figured in "Garden and Forest," 1895, 385.— Along Virgen River in Beaver Dam Mts., Utah, as far north as Silver Reef, 4,000 to 6,000 ft. altitude; Northern Arizona, south of the Kaibab plateau, west to Ivanpah and Resting Springs, California, and east to Charleston Mts., Nevada. Abundant throughout Northern Arizona on the Colorado plateau, the rocks in the Grand Cañon being covered with the plants.— Plate 32.

Specimens examined: — Utah; Dr. Palmer, St. George, 1870, one with leaves very repand, 1877. Arizona;

Bischoff, 1871; Thompson, 1872; Mrs. A. P. Thompson, Kanab, 1872; J. G. Lemmon, Peach Springs, June, 1884, flowers in 6's with rudiments of two more; H. H. Rusby, Peach Springs, 1883, scape flexuous at nodes; J. W. Toumey, Grand Cañon, 1894. Nevada; Coville and Funston, Charleston Mts., March 6, 1891. California; Plant cultivated by S. B. Parish, San Bernardino, from seed obtained at Ivanpah, Cal. The leaves from this plant are very short, and have teeth set on a very prominent fleshy base, end-spines are much elongated, one measuring 5.5 cm. A very dwarf specimen, smaller than A. parviflora, is in the Engelmann herbarium. It was collected by Dr. Palmer, at St. George, Utah, May, 1877. Its leaves are very narrow, and much turned to one side, 4 to 6 cm. long; scape very slender, with small, narrow bracts. In the same herbarium are a few thick leaves, labeled Palmer, 1877, 12 to 36 cm. long, slightly one-sided, contracted to a narrow base, acuminate at apex, with brown end-spines 4 cm. long.

A. Utahensis is the most northern species of Agave, excepting A. Virginica, one of the Manfreda section. It was recommended in England as perfectly hardy, but Mr. J. Wood states that he has not found it so.* It is the Mescal plant of the Piutes and Panamint Indians.

Here, in my judgment, should be placed A. Newberryi Engelm. The only specimens in our herbaria are small fragments of an inflorescence, and a single leaf in the herbaria of the United States Department of Agriculture, and in the Engelmann collection. The leaf is very narrow and probably had an entire margin, but I observe a few breaks in the epidermis where possibly short teeth may have separated.† The end spine is broken off; the pedicels are long, and suggest branching and a paniculate inflorescence, but I strongly suspect the plant to be a monstrous form of A. Utahensis, which species so frequently approaches the

* The Garden, xxxiii. 310.

† Engelm. Trans. St. Louis Acad. iii. 309, Collected Writings, 309.

paniculate character, that it might be placed in the Euagave section with almost as great propriety as in that of Littaea. The flowers seem identical with those of A. Utahensis. I subjoin a description, that the plant may be looked for.

A. Newberryi Engelm.— Leaves rigid, ensiform, about 20 cm. long, 2 cm. wide; end-spine dark-colored, 12 mm. long, grooved (Engelm.); margin probably entire; scape 24 dm. high, with lanceolate bracts 12 mm. long, and a loose elongated sub-paniculate inflorescence; contracted branches 8 mm. apart, 12 mm. long; perianth nearly equal to ovary, tub ... inserted near the base of tube, short.—l. c.

Agave utahensis var. nevadensis Engelm. in herb.
Ivanpah, Mohave Desert, California (t.l.)

Agave scaphoidea Greenman and Roush
St. George, Utah (t.l.)

= Leaves very thick, fleshy, spreading. California.

A. DESERTI Engelm.—Leaves densely clustered, upper ones ascending, lower ones spreading, narrowed at a considerable distance above the base, broadest above the middle, and slenderly acuminate at apex, 30 to 50 cm. long, 5.5 to 6.5 cm. wide; end-spine 3 to 4 cm. long, slender, channeled, grayish with brown tip, very shortly decurrent; teeth stout, gray, 12 to 20 mm. apart, 3 to 4 mm. long, lanceolate-deltoid and recurved above, and minute, close-set, and turned upward below; scape 12 to 30 or even 60 dm. high; bracts close-set below, large, triangular, acuminate, clasping, appressed, dentate, and terminating in a slender black spine 12 to 18 mm. long; branches transversely flattened; flowers 50 to 55 mm. long; perianth yellow, about same length as ovary; segments oblong; filaments inserted at base of segments, and twice their

length; capsules oblong, 35 mm. long, shortly stipitate, cuspidate. Nectar abundant, descending in a shower when scape is shaken (Parish).— Trans. St. Louis Acad. iii. 310, Collected Writings, 309; Terr. Monogr. 49; Baker, Amaryllideae, 178.—From Palm Springs, California, along the eastern slope of the San Jacinto Mountains into Lower California, at altitudes of from 2,500 to 3,000 feet.—Plates 33 and 34.

Specimens examined:— From Emory's Expedition, Nov. 29th, 1846. Torrey Herb.; Dr. Palmer, East of San Felipe, 1875; Geo. N. Hitchcock, East of San Felipe, 1875; G. R. Vasey, Mountain Springs, 1880; S. B. Parish, Mountain Springs, 1880; Parish Brothers, San Felipe, 1882.

Very abundant where found. Miss Johnson has drawn the plate figured, from the original sketch made by Mr. Stanley on the Emory Expedition, Nov. 29th, 1846. The sketch is deposited in the Torrey Herbarium, Columbia College, and was kindly loaned by Dr. Britton, who also gives permission to have it reproduced here.

Lieut. Emory writes* on his discovery of this plant, Nov. 29, 1846: — "We rode for miles through thickets of the centennial plant, and found one in full bloom. The sharp thorns terminating every leaf, were a great annoyance to our dismounted and weary men, whose legs were now almost bare. A number of these plants were cut by the soldiers, and the body of them used for food."

= = Leaves closely imbricated, and somewhat appressed; mature plant usually globose.

A. APPLANATA Lemaire.— Leaves crowded upon a short axis, making a contracted, very symmetrical rosette, which may bear over a hundred leaves, and have a height nearly equal to the diameter; younger leaves ascending, more or less acute or acuminate, or with their upper margins

* Notes on a Military Reconnoissance. Washington (1848). 104.

curved inward with an acuminate effect, lower ones spreading, broader, scarcely or slightly tapering at apex; leaves oblong-lanceolate to spatulate or broadly ovate, 25 to 40 or 60 cm. long, 8 to 17 or 25 cm. broad, 25 to 40 mm. or more thick at cushion above base, rigid, thick, slightly narrowed above the broad clasping base, convex on lower side, flat on upper side in lower half, and concave in upper half, color from cinereous, glaucous, blue-green to grass-green; terminal spine stout, 15 to 25 mm. long, sometimes much longer, purplish-black or brown, often grayish in age, flattened and channeled above; horny margin purplish or brown turning gray, more or less decurrent, sometimes extending to base of leaf; prickles 1 to 2 cm. apart, the lower ones gradually smaller, more close-set and deflexed; scape stout, 25 to 50 dm. (or even 9 to 12 m.) high, bearing numerous large herbaceous bracts, which taper very narrowly and end in a sharp point; panicle a meter or more long, one-third as wide in the middle; branches horizontal or somewhat ascending, stout, flattened horizontally; flowers campanulate spreading, yellow or greenish or brownish-yellow, crowded on short pedicels, 35 to 60 mm. long; segments 15 to 21 mm. long; filaments inserted a very little below cutting of lobes, 35 to 42 mm. long; anthers 14 to 15 mm. long; capsules stout and broad, 3 to 5 cm. long, about half as broad. Nectar abundant. Fragrance pleasant. Propagation by offsets and suckers.

A. applanata is described as a Mexican species. So far as I have been able to ascertain, Dr. Trelease is the only one who has alluded to it as occurring within our borders.* A species in the mountains of Western Texas is apparently the same as the form common in European and American greenhouses under this name. The Texan plant is variable, but many specimens show a resemblance to Dr. Engelmann's A. Parryi which indicates a close relationship. There also seem to be many grades intermediate between

* Report of Missouri Botanical Garden, iv. 191.

in Agaves of group Applanatae he calls it Y. gracilipes (Sierra Blanca)

Pringle's type specimens of A. Huachucensis Baker, and the Rothrock specimens upon which Dr. Engelmann founded his description of A. Parryi. I have, therefore, though with considerable hesitation and reluctance, provisionally brought the three forms together as one species. I have felt obliged to call it A. applanata (though I have not been able to examine the European type specimens), as that is the oldest name. The Mexican type is described as having leaves more narrowed above the base than we find to be the case in the proportions of ours in mature plants. Mr. Baker describes it as having leaves 8 to 12 inches long, 3 to 3½ inches broad at the middle, narrowed to 2 to 2½ inches above the base; flowers greenish-yellow, 2½ to 3 inches long. At the time of my visit to Texas the flowering season was practically over, and I was only fortunate enough to secure a very few retarded flowers, which were yellow and smaller than Baker describes. The herbarium material from Texas is very scanty and consists of a set of leaves labeled A. Wislizeni, accompanied by a very few flowers and capsules, in the Engelmann Herbarium. These were collected by Dr. Havard in the Guadalupe Mountains, October, 1881, possibly with the purpose of showing variations in the forms of leaves. The flowers in this set are much larger than the ones I saw. They have their filaments inserted at or a little above the middle of the tube. If there is no mistake as to the localities in which they were found, it seems to indicate that there is another form which I have not been able to separate by leaf characters. I hope it may be looked for. Similar flowers were collected by C. Wright in New Mexico in 1851 and 1852 (his number 1906). These flowers are not accompanied by leaves. Comparisons should be made with A. Wislizeni, which has a similar insertion of stamens. A. Wislizeni has been credited to Texas by Dr. Engelmann in his manuscript notes, by Dr. Coulter in the Botany of Western Texas, and by Dr. Havard.

The Texas plant is less compact than the other forms; its leaves are very rigid, oblong or spatulate, with a more or less acute, sometimes very acuminate apex, 18 to 30 cm. long, 9 to 12 cm. wide, bluish-green, cinereous, very glaucous; end-spine stout, 30 to 45 mm. long, purplish or reddish-black; horny margin of same color, occasionally traceable as a narrow line extending to base; prickles prominent, large, lanceolate, 7 to 9 mm. long, turned forward and upward; scape 25 to 50 dm. high, branches often ascending, flowers (fresh) 35 to 44 mm. from base of ovary to tips of lobes; ovary 18 to 23 mm. long; tube 2 to 3 mm. long; lobes 15 to 16 mm. long; filaments 35 mm.; anthers 14 mm. long. Style at length slightly exceeding filaments. Perianth, filaments, anthers, styles and stigmas yellow, ovaries green or greenish-yellow. Odor pleasant, not especially strong. Blooms in May and early June.— Lemaire, ex Jacobi, in Hamb. Gartenz. xx. (1864) 550. — Western Texas in Chenate region, Chisos, Guadalupe and Sierra Blanca Mountains, to Fort Davis.— Plate 35. The end-spines are sometimes much elongated. A plant was observed at Sierra Blanca upon which they measured from three to four inches. The few flowers which came under my observation were small and of a bright yellow color. Dr. Havard states that the glaucous leaved form of Agave served the Indians for Mescal, and that the pits for cooking it are to be seen in the Guadalupe mountains. At the Columbian Exposition this plant was labeled A. Parryi. In Dr. Coulter's Texan Botany A. Parryi is included in the flora. The plant is certainly not the one figured by Todaro in Hort. Bot. Panormitanus as A. applanata, but his figure does not correspond with Jacobi's description, nor represent the plant commonly cultivated under that name.

Var. Parryi. Mature plant more compact, globose, large, many specimens measuring from one to one and a half meters in diameter, and having a central pyramidal

bud 15 to 18 cm. in diameter at base, and 25 to 27 cm. high; leaves less rigid, more appressed, proportionally broader, and with much less acumination, from 30 to 38 cm. long above insertion, 10 to 14 cm. wide, often 4 cm. thick at cushion above base, broadest above the middle, color less tinged with blue, less glaucous; end-spine brown, 22 to 25 mm. long; marginal prickles brown, shorter, 3 to 5 mm. long, deltoid-lanceolate, deflexed or straight, very small at base; scape 25 to 50 dm. or more high, very stout, panicle occupying its upper half, both it and its horizontal branches red towards the sun; flowers much larger, 50 to 60 mm. long, tube 8 mm.; segments 20 to 21 mm. long; filaments two to three times the length of segments; capsule stout and broad, 3 to 5 cm. long, about half as broad; seeds 8 mm. in longest diameter. Blooms in June and early July, matures fruit in September. Propagates by offsets and suckers. Nectar is very abundant, descending in a shower when scape is lightly shaken (Dr. E. L. Greene).— *A. Parryi* Engelmann. Trans. St. Louis Acad. iii. 311, Collected Writings, 310; Terr. Monogr. 42; Baker, Amaryllideae, 175. *A. Americana β. latifolia* Torrey, Bot. of Bound. 213. *A. Mescal* Koch in Wochenschrift, 1865, 94. *A. crenata* Jacobi, Monogr. 229.— Southern New Mexico to Central Arizona. Mountains. Plates 36–39.

Specimens examined:—From Arizona, seeds, 1867, Dr. Parry; Bischoff, Wheeler's Expedition, 1871; Dr. Rothrock, No. 274, "Mescal," Rocky Cañon, 6,000 feet, July, 1874, Expedition and Survey of 100th Meridian, Engelmann's type plant, figured in Plate 37. New Mexico, Copper Mines, E. H. Emory, October 19th, 1846, (a colored drawing of this plant, made by Mr. Stanley, in the Torrey Herbarium, Columbia College); Dr. A. M. Bertholet, October, 1877; E. L. Greene, Silver City, June and October, 1880; H. H. Rusby, Bear Mts., 1881.

This plant was discovered by Lieut. Emory, October 18, 1846, near the Copper Mines, Santa Rita Mts., New

Mexico, on his famous trip to California. He states * that "the Apaches make molasses of the plant, and cook it with horse meat." Both Dr. Parry and Dr. Palmer also state that it is the plant used by Indians of the 35th Parallel for making "Mescal," but Dr. Wilcox asserts that the A. Palmeri is the only species used in Arizona for that purpose, and also that the cattle will only nibble the A. Parryi but that they eat the A. Palmeri.

The plant described as blooming at the Missouri Botanical Garden † and reported to have been sent from Arizona immediately previous to sending up its scape, was photographed here at the time, and plate 42 is reproduced from the original. A comparison with the illustrations in the Gardener's Chronicle, in Engelmann's Collected Writings, and the Agricultural Report for 1891, 358, plate vi., will show that the artist, unfortunately, in some way received a wrong impression of the extent of the decurrent leaf margins. The leaves of this plant are narrower, glaucous, spreading, with purplish tips, margin and prickles. The flowers are considerably smaller than the Rothrock type specimens, and the whole plant is very similar to the Texan form.— Plates 42 and 43.

Var. HUACHUCENSIS.— With same compact globose form, grass green, outer leaves very broad, often 25 cm. wide, and exceptionally 37 cm. (Dr. Wilcox), seldom over 65 cm. long; end-spine very stout, 25 mm. long, brown; marginal prickles brown, lanceolate-deltoid, deflexed, 8 to 12 mm. long; scape very stout; flowers yellow, 55 to 60 mm. long; tube 8 to 12 mm. long; segments 18 to 21 mm. long; stamens two to three times as long as segments. Blooms in middle of July and matures fruit in September. Propagates by offsets and suckers.— *A. Huachucensis* Baker, Amaryllideae, 172.— Found in

* Notes on a Military Reconnoissance. Washington (1848). 104.

† Engelm. Gard. Chron., Aug., 1879; Collected Writings, 321.

Huachuca Mountains, Arizona, from an elevation of 5,000 feet to the top of the mountains.— Plates 40 and 41. Professor Toumey states that the plants often have a purplish cast which extends even to the flowers.

Specimens examined: —From J. G. Lemmon, September, 1883; C. G. Pringle, June, 1884, 5,000 to 8,000 feet; Dr. T. E. Wilcox, 1893; Professor J. W. Toumey, July 17, 1894.

++++ Stamens inserted near the middle of tube.

= Leaves relatively broad and short, deep-green, not glaucous; plant caulescent, globose. California.

A. SHAWII Engelm.— Shortly caulescent, growing in large, dense rosettes from 5 to nearly 10 dm. in diameter, and, including the trunk, of about the same height; trunk 20 to 30 cm. long, clothed with the bases of the old leaves; leaves oblong-spatulate, acuminate, 25 to 40 cm. long, 8 to 12 cm. wide, 5.5 cm. thick at the cushion-like lower portion, broadest above the middle, deeply concave with narrowly acuminate effect in upper portion of young leaves; end-spine stout, 30 to 35 mm. long, channeled above, rounded below; margin broad, decurrent nearly or quite to base; prickles largest at middle of leaf, 6 to 15 mm. long, lanceolate, deltoid, close-set, generally turning outward and upward; color of end-spine, margin and prickles creamy white with a light salmon tint, changing successively to yellow, salmon, red, brown and gray as the leaves are maturing; margin and prickles sometimes become detached as in A. Lechuguilla; scape 24 to 36 dm. high, 50 to 65 cm. thick, nearly covered with leafy, appressed, deltoid-acuminate bracts 8 to 15 cm. long, with brown scarious margins and spiny tips; branches of panicle flattened, 10 to 22 cm. long, longest ones towards the middle, all subtended by large spreading bracts; flowers sessile at ends of branches in large compact clusters of 20 to 30, surrounded by thick, leafy bracts; flowers 75 to 87 mm. long; perianth greenish-yellow, infundibular,

broad, 4 to 5 cm. from base of style to tips of lobes, which are a little longer than the tube; filaments inserted a little above the middle of tube and much protruded; anthers 27 mm. long; style at length 11 cm. or more; capsule sessile, cuspidate, 6 to 7 cm. long, slender; seeds 7 to 8 mm. in longest diameter; flowers filled to the brim with a whitish, slightly nauseating nectar.—Trans. St. Louis Acad. iii. 314 and 579, Collected Writings, 311, 316. (Plates 44 and 47 are taken from Engelmann's illustration of the plant which bloomed at the Garden).— Terr. Monogr. 49; Baker, Amaryllideae, 172.— On mesas near coast in Southwestern California, as far north as Point Loma and extending southwards in Lower California. Abundant in vicinity of Western Initial Boundary Monument.— Plates 44 to 47.

Specimens examined:— From Dr. Parry; Dr. Palmer, 1875, San Diego; G. R. Hitchcock, Nov., 1875; Missouri Botanical Garden, flowers, Feb., 1877; C. R. Orcutt, Lower California, April, 1886; G. W. Drown, San Diego, July, 1895; T. S. Brandegee, Lower California, April, 1892.

= =Leaves relatively narrow, often long; acaulescent. New Mexico and Arizona.

A. PALMERI Engelm.— Leaves numerous, ascending and spreading, deep green, usually concave on upper side, more or less glaucous, sometimes crenate, 20 to 150 cm. long, 5 to 12 cm. wide, oblanceolate, tapering; end-spine slender, brown, channeled, 20 to 35 mm. long; horny margin more or less decurrent; prickles rather close set, variable in size, large ones often alternating with smaller, flexuous or recurved; scape 25 to 36 dm. or even 65 dm. high, and may be as much as 15 cm. in diameter at base, clothed with short, broad bracts; panicle long, open; flowers greenish or yellowish-white, sometimes yellow, 40 to 55 mm. long; segments 12 to 15 mm. long, shorter than the tube, the exterior ones hooded and thickened at the apex, interior ones broader; filaments long, inserted above or below the middle

of tube, purplish; anthers 12 to 15 mm. long; capsules slender, 30 to 50 cm. long, 15 to 17 mm. wide; seeds very small for the group, 4 to 6 mm. in largest diameter. Odor very offensive.—Trans. St. Louis Acad. iii. 319, Collected Writings, 313; Terr. Monogr. 42; Baker, Amaryllideae, 178.— Southeastern Arizona and Southwestern New Mexico, ascending to 6,300 feet.—Plates 48 to 52.

Specimens examined:— From Dr. Palmer, Camp Bowie, New Mexico, 1869, and Nov., 1870, locality not given; Dr. Parry, capsule and seeds, no date; Camp near Sun Flower Valley, Dr. Gerard, No. 2, 1873; Santa Rita Mts. Dr. Engelmann, Sept., 1880; Benson, Arizona, Dr. G. R. Vasey, 1881; Santa Catalina Mts., Mr. C. G. Pringle, June, 1881, flowers yellow, and June, 1882; Mr. C. T. Brandegee, Santa Rita Mts., Nov., 1891; Dr. T. E. Wilcox, Fort Huachuca, 1893; Prof. J. W. Toumey, Santa Catalina Mts., July and December, 1894, and June 20, 1895.

Blooms early in July and matures fruit in September (Toumey). It propagates itself by offsets and sometimes also by suckers. A. Palmeri varies greatly in size, and proportional length, breadth, and thickness of leaves. Whether these differences remain constant and are correlated with others entitling them to varietal distinction I have not been able to determine. Quite young plants in the Huachuca Mountains are said to be difficult to distinguish from those of A. applanata Huachucensis, and many very short-leaved plants grow there, but the mature plants of A. Palmeri are usually recognized at a glance. The inflorescence is looser and more spreading, the flowers have shorter, broader segments, the filaments are inserted deep in the tube, the capsules are longer and more slender, the seeds are much smaller, and the mature leaves much narrower and longer. I found a plant of this species a few miles from Fort Bayard, whose leaves had a brown margin extending to the base. Professor Toumey reports that plants of A. Palmeri often have a purplish cast which

extends even to the flowers. Dr. Wilcox states that after making many and careful inquiries he is convinced that A. Palmeri is the only species used in Arizona for food or for making the liquor "Mescal."

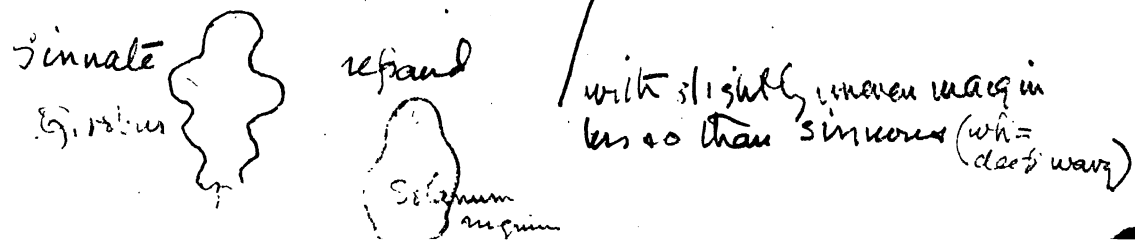
= = = Leaves very rough.

A. ASPERRIMA Jacobi. — Acaulescent; leaves few, with few fibers, broadly spreading, very concave on upper side, rounded on lower, very rough on both sides, dull green, glaucous, 45 to 120 cm. long, thick at base, broadest for some distance in the middle, and tapering very narrowly to the compressed apex; end-spine brown, 30 to 55 mm. long, slender, terete, very pungent, decurrent as a narrow border for a considerable distance; margin somewhat repand; prickles commencing 10 to 15 cm. below apex, large, deltoid-cuspidate, 7 to 10 mm. long, spreading or reflexed, rather remote; flowers 75 mm. long; ovary 30 mm.; segments 20 mm.; filaments attached a little above the middle of tube, 70 mm. long; anthers very large, 25 to 30 mm. long: — Hamb. Gartenz. xx. (1864) 561, Monogr. 61; Baker, Amaryllideae, 173.— Plate 53.

This plant is reported as occurring spontaneously in Texas at a point about twenty miles northeast of San Antonio, and at Eagle Pass. From the former place Mr. Gurney received a plant a number of years ago, and Dr. Ten Eyck has sent a specimen leaf from the latter. Dr. Ten Eyck was kind enough to search for fruiting capsules but without success. A specimen in the Garden Herbarium sent by Mr. C. G. Pringle from "mesas near Jimulco, State of Coahuila, Mexico, April 9, 1886," has prickles more numerous than those upon the Texas specimens. The plant should be looked for in Texas at other points between San Antonio and the Rio Grande.

+-+ Leaf without horny margin; edge repand; teeth prominent.— AMERICANAE (Baker). (Look for A. Palmeri under Submarginatae.)

A. AMERICANA L.— Leaves oblanceolate to spatulate, 10 to 20 dm. long, 15 to 22 cm. wide, glaucous; end spine 35



to 50 mm. long, brown; marginal prickles brown, deltoid-cuspidate, unequal; scape 8 to 12 m. high, with 20 to 40 branches; flowers 75 to 90 mm. long; segments 25 to 30 mm. long, yellowish; filaments inserted above middle of tube, twice as long as segments; capsule oblong, 5 cm. long.—Sp. Pl. (1753) 323; Jacobi, Monogr. 5; Terr. Monogr. 45; Baker, Amaryllideae, 180; Danielli in Nuov. Giorn. Bot. Ital. xvii. 49 to 138.—This handsome and useful* species is said to have become spontaneous at a few places in Southern Texas. Mr. Nealley reports it as being abundant between San Antonio and Eagle Pass, among Chapparal. Professor Rolfs states that it flourishes and blooms in Florida without protection, as far north as Eustis in Lake County, and at Braidentown on the East coast. With protection it has bloomed at Jacksonville. It appears to stand the frost better than the other Agaves found in Florida, excepting of course the A. Virginica, which is reported only from the northern part of the State. Dr. Havard recommends its cultivation† for the manufacture of fiber, pulque and mescal. This is the species commonly called Maguay and Century Plant.

The central pith (pita) of Maguay stalks is very commonly used by entomologists for lining their insect boxes. Humboldt states ‡ that next to maize and potato this plant is the most useful of all the productions which nature has supplied to the mountaineers of tropical America. He mentions its use for fiber, pulque, and mescal, and also states that the juice (*xugo de cocucuyza*) of immature plants is very acrid and is successfully employed as a caustic in the cleaning of wounds. The prickles which terminate the leaves served formerly for pins and nails to the Indians. The Mexican priests pierced their flesh with them in their acts of expiation. He says that the ancient Aztecs macerated the leaves

* See section "Economic Uses" in preliminary portion of this paper.

† Proceedings U. S. National Museum, 1885, 519.

‡ Essai Politique sur la Nouvelle Espagne (Paris, 1811), tom. ii. 418 to 423.

and disposed them in layers like the fibers of the Egyptian papyrus and the mulberry (Broussonetia) of the South Sea Islands. This formed paper upon which their hieroglyphics were painted. Their manuscripts were folded in rhombic form and were bound in some resemblance to our quarto books by fastening wooden boards to the extremities. Humboldt states that no nation of the old continent made such an extensive use of hieroglyphics and in none do we see real books bound in the way described.

+-+-+ Leaf without horny margin, slightly if at all repand; teeth small if present.— RIGIDAE (Baker).

++ Somewhat caulescent; leaves usually entire.

A RIGIDA SISALANA Engelm.— Leaves bright dark green, 120 to 180 cm. long, 10 to 14 cm. wide, narrowed, thickened and keeled above the base, broadest a little above or at the middle, and tapering to the apex; terminal spine terete, reddish-brown, not channeled, but slightly indented at the base, 1 to 2 cm. long, not decurrent; margin usually entire, but often with occasional sharp, unequal prickles, and sometimes with stout ones; scape 45 to 90 dm. high; panicle much branched, sometimes covering half the length of the scape, and having a width about half its length; flowers 55 to 65 mm. long; ovary rather broad; perianth campanulate, 33 to 35 mm. long; segments a little longer than the tube; filaments inserted above the middle, nearly at the line which would mark the upper third of tube, 55 to 60 mm. long; anthers 2 cm. long; capsules oblong, about 50 mm. long and half as wide. Propagation by pole plants and suckers.— Trans. St. Louis Acad. iii. 312, Collected Writings, 312; Baker, Amaryllideae, 181.— Yucatan, Southern Florida below the frost line, and the adjacent islands, including the Keys and the Bahamas.— Plates 54, 55 and 56. Dr. Havard and Dr. Coulter state that it occurs in Southern Texas.

Specimens examined: — From Merida, Yucatan, Dr. Schott, 1865; Key West, Wright, Parry, and Brummel,

1871; Miami, A. P. Garber, July, 1877; Indian Key and Biscayne Bay, A. H. Curtiss, 1872; Tampa, Dr. Geo. Vasey, 1892; Jupiter, C. R. Dodge, 1891; H. J. Webber, 1895; C. T. McCarty, 1895; Missouri Botanical Garden.

The A. rigida sisalana seems to have become fully naturalized in Florida, but it is found near spots that at some time have been under cultivation. It was first taken to Florida by Dr. Perrine from Yucatan in 1836.* It is called Yaxci, Yaxqui (pronounced Yaash-ki), by the natives in Yucatan, and is cultivated by them to some extent, but is not so productive there as their Saqui, or A. rigida elongata. In Florida the fiber is finer, longer, and stronger than that obtained from the Yucatan plants, and much is hoped for in its cultivation. It is growing spontaneously at many points along the coast between Titusville on the east and Charlotte Harbor on the west. Its largest tract is Indian Key; the largest and finest plants are found at Upper Metacombe and Boca Chica Keys. Plants were seen by Mr. Dodge on the former whose leaves were two feet above a man's head. Other large tracts are on Key West, the group of Keys including Lignum Vitae, etc., the old Perrine Grant, Biscayne Bay, Miami, Indian River, Jupiter and Juno. It has also been known in Polk County in the interior for the past forty years, where it forms impenetrable thickets "unharmed by frost, fires or any other cause." Two patches covering a quarter of an acre are said to have grown from two original plants.† The plant is also said to have been successfully introduced on the Lower Rio Grande.‡

In Florida this Agave is usually known by the name of Sisal Hemp. Its reproduction by means of "Pole Plants"

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* Senate Document No. 300, March, 1838. Report of U. S. Department of Agriculture, 1869. Fiber Investigations, C. R. Dodge, Reports 3 and 5, Depart. Agric., 1891, 1893.

† Fiber Investigations, No. 5, (1893), 17, U. S. Dept. Agric., C. R. Dodge.

‡ Proceedings of U. S. National Museum, 1885, 519, Dr. V. Havard.

is very interesting. After the blossoms begin to wither and fall away, buds develop from the stalk below and grow into small plants. After attaining a size of from three to ten inches, they fall to the ground and take root. They have very great vitality and develop into stout, strong plants. In cultivation, they are much used for planting. A single flowering stalk (pole or mast) will bear from one to two thousand pole plants; as many as twenty-five hundred have been reported. The species is said to have spread over the Keys by means of buds from the poles being driven by the currents of air and water.

This Agave matures in from six to seven years. By cutting its leaves, the period of poling is retarded, and the size and productiveness of the pole is lessened. Its average life in Florida is twelve years.

It is a question whether this variety can be divided into two forms which grow independently. Mr. Dodge* speaks of a distinctly spined form growing in some places, and the common smooth-leaved form in others. He also quotes from those who assert that both forms may be found on a single pole, and that a plant is sometimes found whose leaves are spiny-edged on one margin and entire on the other. In Yucatan the plant bears spines, and it is said that the influence of soil and climate tend to produce the smooth-leaved form from the other. The shortly spined† form is invariably shorter-leaved and stockier, and the smooth-leaved form spreads much the faster.

↔ ↔ Caulescent; teeth prominent.

A. DECIPIENS Baker. — Trunk 10 to 15 dm. long, clothed with the old recurved leaves; young leaves erect and ascending, mature ones spreading, becoming more and more reflexed, old ones recurved; fleshy leaf-bases clasping the considerably elongated axis and giving it a swollen and spindle-like effect; leaves usually

* Report of 1893, p. 23.

† Dodge, Report of 1891, p. 14.

10 to 13 dm. long, at Lake Worth 20 to 25 dm. long, 6 to 10 cm. wide, narrowed and thickened above the broad base, widest near the middle, acuminate at the apex, brighter green than the A. rigida sisalana; end spine brown, 10 to 15 mm. long, terete; marginal prickles small, but made conspicuous by the somewhat repand margin, very sharp, rather close-set and usually recurved; scape 50 to 60 dm. high, rather loosely branching in upper half; flowers greenish-yellow, about 75 mm. long; tube funnel-shaped; segments 16 to 17 mm. long, twice as long as tube; filaments inserted at the middle of the tube, 33 to 37 mm. long; ovary oblong; pole plants and suckers very abundant.— Kew Bulletin, July and August, 1892, 184; Fiber Investigations, Report No. 5 (1893), 33, U. S. Dept. Agric.— Plates 57, 58, 59.— Southeastern Florida, Jupiter, Biscayne Bay, Lake Worth and other points along the coast to Key West. — Specimens examined: — From Mr. C. R. Dodge, Southern Florida, 1892, 1895; Mr. C. T. McCarty, 1895; Mr. H. J. Webber, 1895; leaves and plants growing in the Garden.

This plant was so named by Mr. Baker on account of its having been frequently mistaken for the true sisal hemp, the A. rigida sisalana. This has caused considerable pecuniary loss to those who have unfortunately planted it in place of the other, as its fiber is softer and weaker. Though whiter and finer, it is very inferior to the sisalana both in quantity and quality. The false sisal may be easily distinguished by its tall trunk and bright green radiating leaves. The decipiens will grow in the shade but the sisalana will not, and while the latter is found near the coast, and near to present or past points of cultivation, the false sisal is found at a distance from both. In some places, Sand's Key, Lake Worth, etc., the growth of this form is very luxuriant; sometimes it rises to the height of four meters from the ground, and bears leaves two to two and a half meters long, and a mast over six meters high, and seven to ten centimeters in diameter. Its juice is very

acrid, and is poisonous to the human skin, causing intense irritation. It is a very showy and handsome plant.

Mr. Dodge* refers to this plant as being cultivated in the Botanical Garden at Washington, D. C., under the name of A. Mexicana. There is also a fine plant at one time labeled A. Mexicana growing in the Missouri Botanical Garden, which is figured in plate 56. This is obviously not A. Mexicana, but identical with the Florida plants. Mr. Gurney, the head gardener, says that it was sent to Dr. Engelmann by Dr. Parry from Northern Mexico. This perhaps indicates the native home of the species. A glance at the plate will show the abundance of suckers developed close to the trunk of the parent plant. The old recurved leaves are trimmed off.

↔ ↔ ↔ Acaulescent; teeth very minute.

A. SP.— Leaves ascending and spreading, on young plants rather thin, brittle, and much recurved, on old plants very numerous, fleshy, heavy, and slightly recurved, light bluish-green, glaucous, 15 to 28 dm. long, 20 to 25 cm. wide, very thick at base, broadest at the middle, tapering to the apex, somewhat rough; end spine brown, terete, very narrowly channeled for a short distance; marginal prickles very minute and close-set, somewhat tinged with brown; scape nearly 13 m. high, branching at about one-fifth of the distance from the top; branches bracteate; flowers yellowish-green, (dried) 55 mm. long; segments narrow, 23 mm. long; filaments inserted above the middle of the tube, protruded for a considerable distance; ovary 20 mm. long, slender; pole plants and suckers numerous.— Plates 60 and 61.— Florida. Occasionally to be met with from Indian River to the Perrine Grant,— at Jupiter, Lake Worth, Cocoanut Grove, etc.

Young plants were received at the Garden last season from Mr. Kirk Munroe, Cocoanut Grove, Mr. C. T.

* Report No. 3, Fiber Investigations, Dept. Agric., 1891, 43.

McCarty, Ankona, Mr. H. J. Webber, and Mr. C. R. Dodge.

Mr. Munroe writes that a plant of his figured by Mr. Dodge * grew finally to be eight feet tall and about thirty feet in circumference before it flowered. A single leaf about five feet long, weighed eight pounds. It matured at seven years of age and "shot up a pole 40 feet high." I have based my description of the inflorescence upon his plant and a specimen sent by Mr. Webber from the sub-tropical laboratory at Eustis. No capsules were reported from either place.

To avoid further confusion in nomenclature, I refrain from giving a name to this plant until it is possible to obtain further data. Mr. Dodge states that it is allied to A. Americana, and that the fiber is similar in every respect, crinkly and elastic, and very white. He writes me that Mr. Smith of the Botanic Garden at Washington calls the plant A. pruinosa. I find, however, that A. pruinosa is described as having no pungent end-spine and is altogether a decidedly smaller plant, with different leaf proportions. Mr. Webber writes that it is cultivated at Eustis under the name of A. rigida recurvata. I am unable to trace any record of such a variety of A. rigida, and do not feel sure that the plant belongs to that species.

Reasoner Brothers, of the Royal Palm Nurseries, of Oneca, Florida, catalogue and figure a plant under the name of A. recurvata, which I supposed might be identical, though they do not state whether the plant is a Florida Agave, or give any adequate description. Upon writing to them, they replied that the name is a misnomer, and that they do not know of the plant being so catalogued elsewhere. They suggest that it may be A. striata var. recurva. This it certainly is not. Upon receiving the plants last spring, I was struck by their resemblance to specimens in the Agave House here labeled A. miradorensis, and this resemblance

* Report No. 5 (1893), 38.

has now become even more striking in all points save in rapidity of growth; these young specimens having in a single year nearly reached the size of the older plants, which have scarcely grown at all. These older plants were raised from seed sent to the Garden several years ago. Mr. Gurney says that they are the same as plants called A. albicans by Dr. Engelmann, but that species belongs to the Littaea section. The plants in question seem to correspond better with those from Florida than to the descriptions given of either A. miradorensis or A. albicans.

A. SP.— A fragment of a leaf sent by Dr. B. D. Ten Eyck from Eagle Pass, Texas, Feb. 7, 1895, still remains unidentified.

The leaf is dark green, with a smooth shining surface, about 25 dm. long, 12 to 20 cm. wide, tapering to the apex, with a slight compression at the tip, giving an acuminate aspect, 3.5 mm. thick, soft, flexible, with few fibers; end-spine 4 cm. long, reddish-brown, slightly channeled on upper side for about half the length, and decurrent for a short distance; margin entire.

Dr. Ten Eyck states that this plant, which is probably a Mexican species, is found spontaneous on the northern side of the Rio Grande in the vicinity of Eagle Pass. I have been unable to learn anything in regard to its inflorescence. Dr. Ten Eyck thinks that its occurrence may possibly have been caused by seeds carried to the spot from cultivated plants. He looked for fruit without result.

EXPLANATION OF PLATES ILLUSTRATING AGAVES.

The line drawings have been made by Miss Grace E. Johnson under the supervision of the author, from herbarium material or from living plants. The half-tones are from photographs of plants under cultivation or in their native habitats.

Plate 30 is taken from Dr. Trelease's plate (No. 32), in the Fifth Report of the Garden. Plates 44 and 47 are

from Engelmann's Collected Writings, pages 315 and 319. Plates 54, 55 and 58 are reproduced by permission of the Secretary of Agriculture from Reports No. 3 and No. 5 on Fiber Investigations, by Mr. C. R. Dodge.

Plate 26. *A. Virginica* L.—Photograph of wild plants at Jefferson Barracks, St. Louis, taken by Mr. H. J. Webber.

Plate 27. *A. Virginica* L.—1, Leaf from living plant in Missouri Botanical Garden, × ½; 2, inflorescence from Little Stone Mountain, Ga., × ½; 3, interior of flower, × 1; 4, opened bud showing folding of filaments, × 1; 5, flower from Shannon County, Mo., showing curvature of filaments near point of insertion; 6, ripened capsules, × 1; 7, seed, × 2.

Plate 28. *A. maculata* Regel?—1, Living plant at the Garden commencing its spring growth, × ½; 2, margin of leaf, × 3; 3, portion of inflorescence from Corpus Christi, × ½; 4, flower of same, split open, × 1; 5, flower from Dr. Wislizenus, No. 373, × 1; 6, flower from Dr. Palmer, No. 1306, × 1; 7, stigma, × 4.

Plate 29. *A. Schottii* Engelm. — 1, Inflorescence, × ½; 2, flower split open, × 1; 3, fruit, × 1; 4, capsule, × ½; 5, *A. Schottii serrulata*, plant, × ½; 6, margin of leaf base, × 3; 7, flower split open, × 1.

Plate 30. *A. parviflora* Torrey.— 1, Vegetating plant, × 1; 2, leaf, × 1; 3, portion of fruiting spike, × 1; 5, seed, × 2;— all from Professor Toumey's material; Fig. 4, capsule, × 1; 6, leaf, × 1; 7, flowers, × 1; 8, seed, × 2; —all from Schott's specimens in the Engelmann herbarium.

Plate 31. *A. Lechuguilla*, Torrey.— 1, From habit sketch taken by Dr. Trelease in Texas; 2, outer side of leaf of plant in the Garden, × ½; 3 and 4, cross-sections at middle and near base of leaf; 5, end-spine and decurrent margin seen from face of leaf; 6, portion of inflorescence, × ½; 7, flower split open, × 1; 8, fruit in position, × ½; 9, capsule, × 1; 10, seed, × 2.

Plate 32. *A. Utahensis*, Engelm.— 1, Leaf from Peach Springs, Arizona, × 1; 2, portion of inflorescence from St. George, Utah, × ½; 3, flower split open, × 1; 4, capsule, × 1; 5, seed, × 2.

Plate 33. *A. deserti*, Engelmann.— Photograph taken by Parker, San Diego, kindly sent by Mr. F. Sutphens, Witch Creek, Cal.

Plate 34. *A. deserti*, Engelm.— 1, Habit sketch reproduced by permission of Dr. Britton from colored drawing in Torrey Herbarium, made by Mr. G. M. Stanley, on Emory's Expedition, Nov., 1846; 2, portion of inflorescence, × ½; 3, insertion of stamens; 4, capsule, × 2.

Plate 35. *A. applanata*, Lem.— 1, Outer side of leaf of large plant, × ½; 2, end-spine and margin from face of leaf, × ½; 3, outer leaf of young plant, × ½; 4, portion of fruiting branch, × ½; 5, interior of flower, × 1. All collected by author on Sierra Blanca Mts., Tex.

Plate 36. *A. applanata Parryi.*— From photograph sent by Dr. Parry to Dr. Engelmann, 1868, showing plant in San Francisco Mountains, Arizona.

Plate 37. *A. applanata Parryi.*— 1, Leaf, × ½; 2, branch of inflorescence, × 1; 3, flower with perianth split open, × 1; 4, anther, × 1; 5, capsule, × 2. All from Engelmann's type specimens of A. Parryi, collected by Dr. Rothrock, at Rocky Cañon, Arizona.

Plate 38. *A. applanata Parryi.*— From photograph taken by author near Copper Flats, New Mexico. Opuntia arborescens Engelm. is seen at the left.

Plate 39. *A. applanata Parryi.*— 1, Outer side of leaf of medium sized plant, × ½; 2, end-spine and margin from face of leaf; 3, flower, showing insertion of stamens, × 1; 4, portion of fruiting branch, × ½; 5, capsule, × 1. Leaf from plant sent to Garden from Pinos Altos Mts.; flowers and fruit from Copper Flats, New Mexico. All collected by author.

Plate 40. *A. applanata Huachucensis.*— From photograph taken by Dr. T. E. Wilcox, U. S. A., in Huachuca Mts.

Plate 41. *A. applanata Huachucensis.* — Habit sketch of young plant sent by Dr. T. E. Wilcox, U. S. A., from Fort Huachuca.

Plate 42. *A. applanata* Lem.—From photograph of plant blooming at the Garden, June, 1879.

Plate 43. *A. applanata* Lem.— From specimens in Engelmann Herbarium, of plant blooming in the Garden, June, 1879. 1, Leaf dried without much pressure, therefore wrinkled, × ½; 2, 3, 4, portions of bracts, × ½; 5, flower from within, × 1; 6, capsule, × 1; 7, seed, × 2; 8, portion of surface of seed, much magnified.

Plate 44. *A. Shawii* Engelm.—From Dr. Engelmann's Collected Writings, page 315.

Plate 45. *A. Shawii* Engelm.— 1, From photograph taken by Parker & Parker, San Diego, borrowed from Gray Herbarium; 2, from photograph of young plant at Missouri Botanical Garden, in 1887.

Plate 46. *A. Shawii* Engelm.—1, Leaf of plant at the Garden, × ½; 2, bract of inflorescence, from Engelmann herbarium, × ½; 3, capsule, × 1.

Plate 47. *A. Shawii* Engelm. — From plant blooming at the Garden, Feb., 1877. Plate taken from Engelm. Collected Writings, 319. 1, Diagram of flower; 2, outer view of top of flower-bud; 3, inner view of same; 4, an opening bud; 5, section of same; 6, flower fully open; 7, flower on third day; 8, flower on fifth day; 9, stigma closed, × 4; 10, stigma expanded, × 4; 11, pollen grains, × 100.

Plate 48. *A. Palmeri* Engelm. — From photograph taken by Dr. T. E. Wilcox, U. S. A., near Fort Huachuca, Arizona.

Plate 49. *A. Palmeri* Engelm.— From photograph taken by Dr. Trelease, of plant sent to the Garden by Mrs. Angus Campbell, from Mule Springs, New Mexico. —The repand form.

Plate 50. *A. Palmeri* Engelm. — 1, Sections from apex, middle and base of leaf of plant collected by author at Lone Mountain, New Mexico, × 1; 2, sections from apex, middle and base of leaf of plant sent by Mrs. Angus Campbell from Mule Springs, New Mexico, × 1.

Plate 51. *A. Palmeri* Engelm. — 1, Mature leaf showing margin extending to base, × ½; 2, leaf of young plant, × ½; 3, apex of same

from face of leaf; 4, portion of flowering branch, × ½; 5, opened flower, × 1. All collected by author near Lone Mountain, New Mexico.

Plate 52. *A. Palmeri* Engelm. — 1, Flowering branch, × ½; 2, flower, × 1; 3, insertion of stamens; 4, capsules, × 1; 5, seed, × 2.

Plate 53. *A. asperrima* Jacobi. — 1, Leaf of plant in Missouri Botanical Garden, from near San Antonio, Texas, × ⅛; 2 and 3, sections of same; 4, margin of same, × 1; 5, margin of leaf from Eagle Pass, × 1; 6, margin of leaf from Pringle's specimen, × 1; 7, flower from Pringle's specimen, × 1.

Plate 54. *A. rigida sisalana.*— From Plate I. of Report No. 3, by Mr. C. R. Dodge, on the Leaf Fibers of the United States.

Plate 55. *A. rigida sisalana.*— From Plate V. of Report No. 3. Plant in flower, and a side branch of pole, showing pole plants.

Plate 56. *A. rigida sisalana.*— 1, Leaf, × ⅛; 2, 3, and 4, sections from top, middle, and base of leaf, × 1; 5, portion of inflorescence, × ½; 6, interior of flower, × 1; 7, young pole plant, × ½.

Plate 57. *A. decipiens* Baker.— From photograph taken of plant at the Garden, in 1887.

Plate 58. *A. decipiens* Baker.— From figure of inflorescence on page 30 of Report No. 5, by Mr. C. R. Dodge, on Leaf Fibers of United States.

Plate 59. *A. decipiens* Baker.— 1, Leaf, × ⅛; 2, 3, and 4, sections from apex, middle and spreading base of leaf, × 1; 5, portion of branch of inflorescence, × ½; 6, flower, × 1.

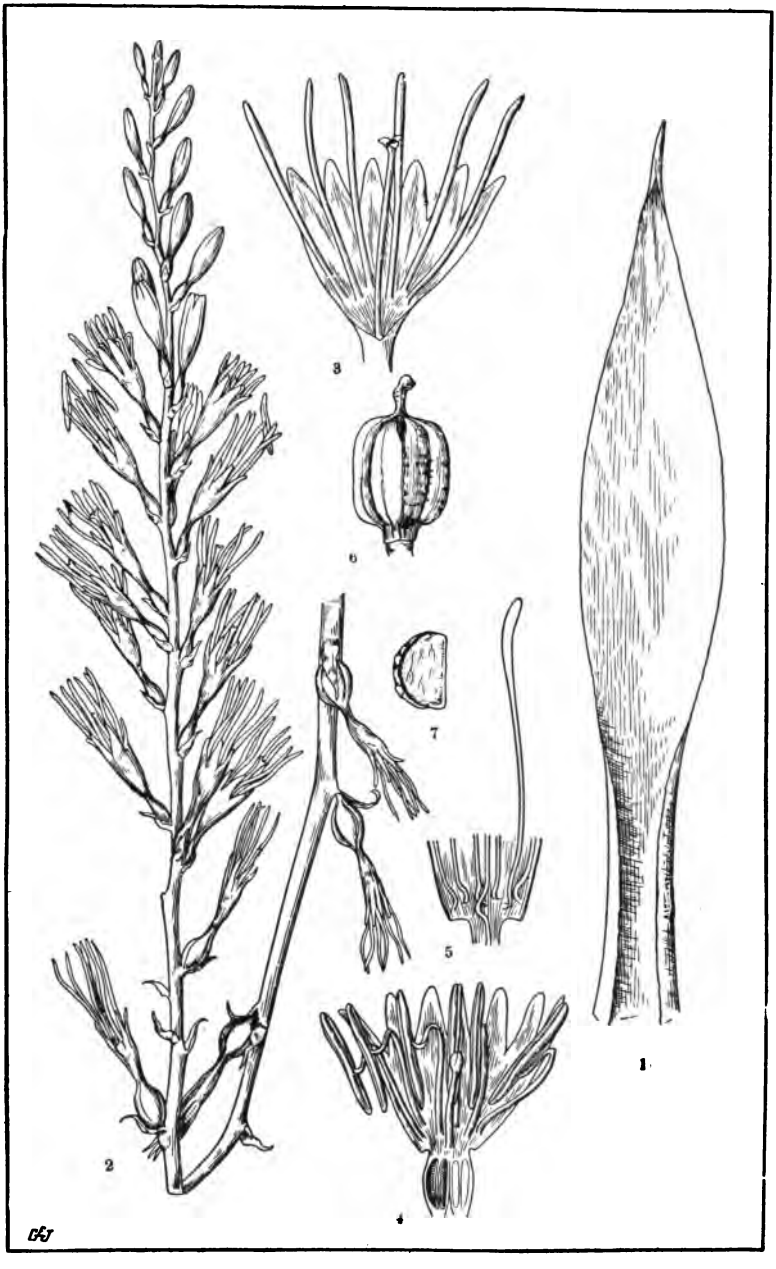
Plate 60. *A. Sp.*— From photograph of plants sent to the Garden by Mr. C. T. McCarty, from Ankona, Florida. Taken by the author.

Plate 61. *A. Sp.*— 1, Portion of leaf, × ⅛; 2, 3, and 4, sections of apex, middle and base of leaf, × 1; 5, portion of margin, × 2.

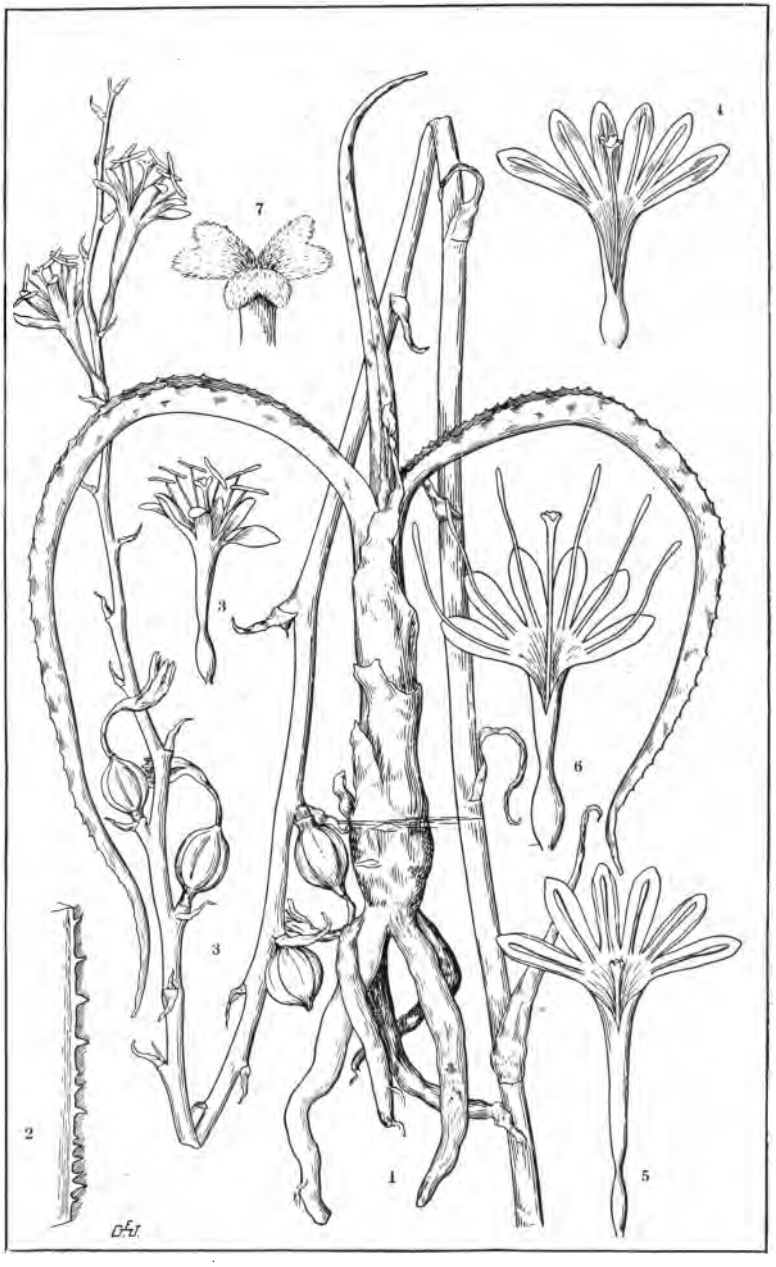
Plate 62. *A. horrida micracantha.*— From photograph of plant at the Garden, taken by the author, January, 1895.

Plate 63. 1, *A. Virginica tigrina* Engelm., young plant beginning its annual growth, sent to Garden by Dr. Mellichamp, × ½; 3, seedling of *A. applanata Huachucensis* with testa still at apex of cotyledon, × 1; 2, same, further advanced, × 1; 4, margin of first leaf, × 5; 5, 6, 7, flowers of *A. horrida micracantha;* 8, 9, 10, flowers of *A. brunnea* Watson. All from plants at the Garden.

AGAVE VIRGINICA.



AGAVE VIRGINICA.



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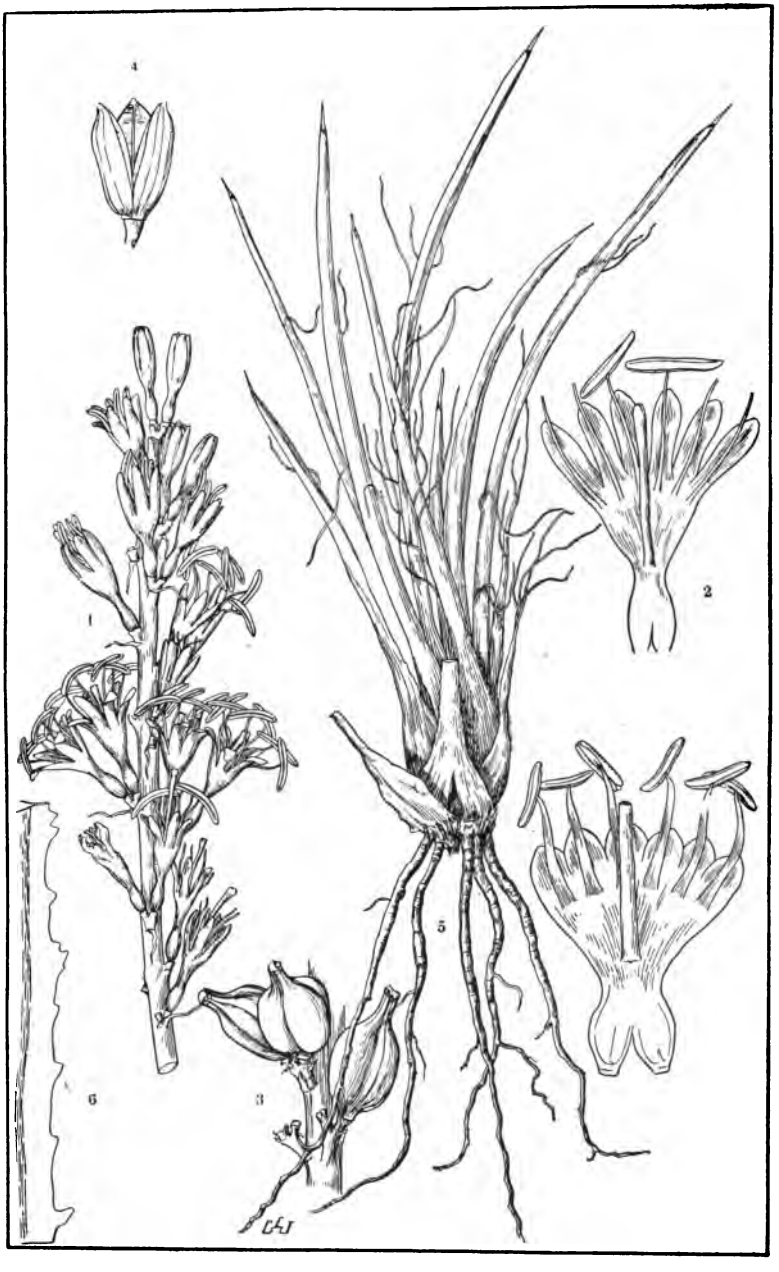

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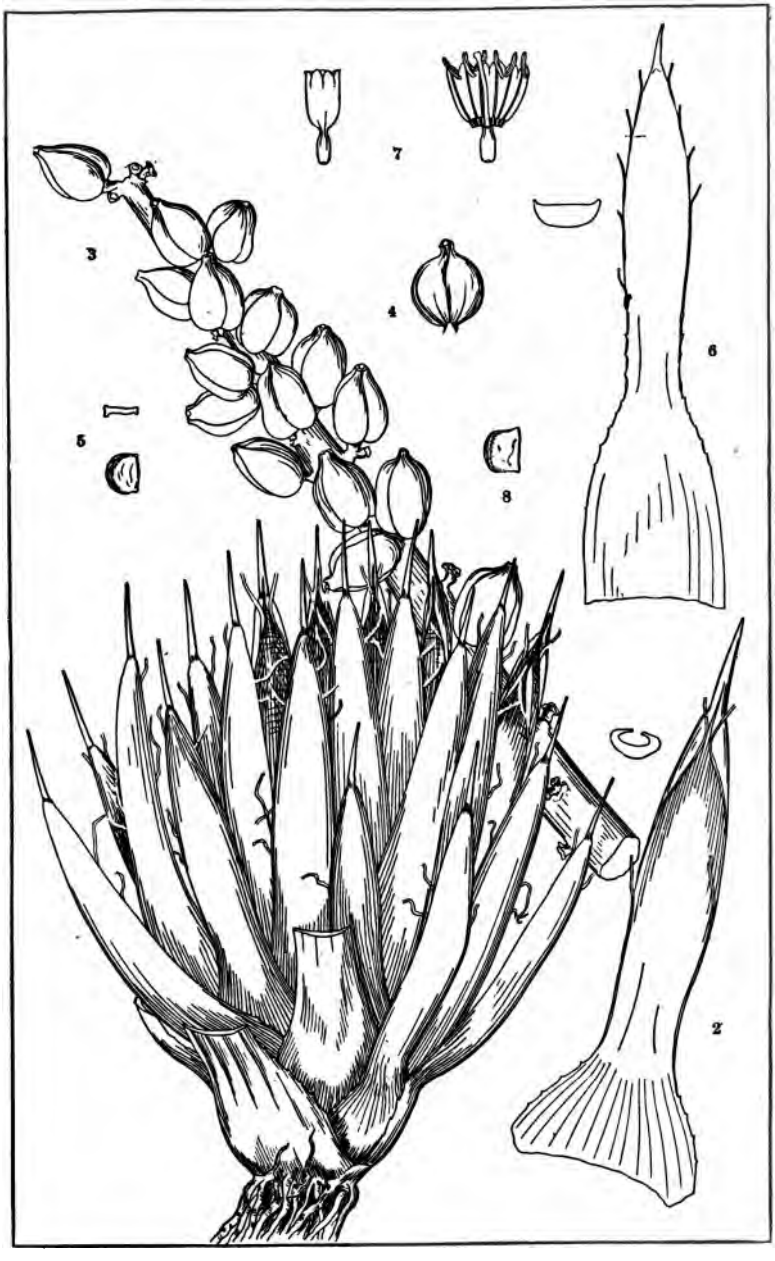

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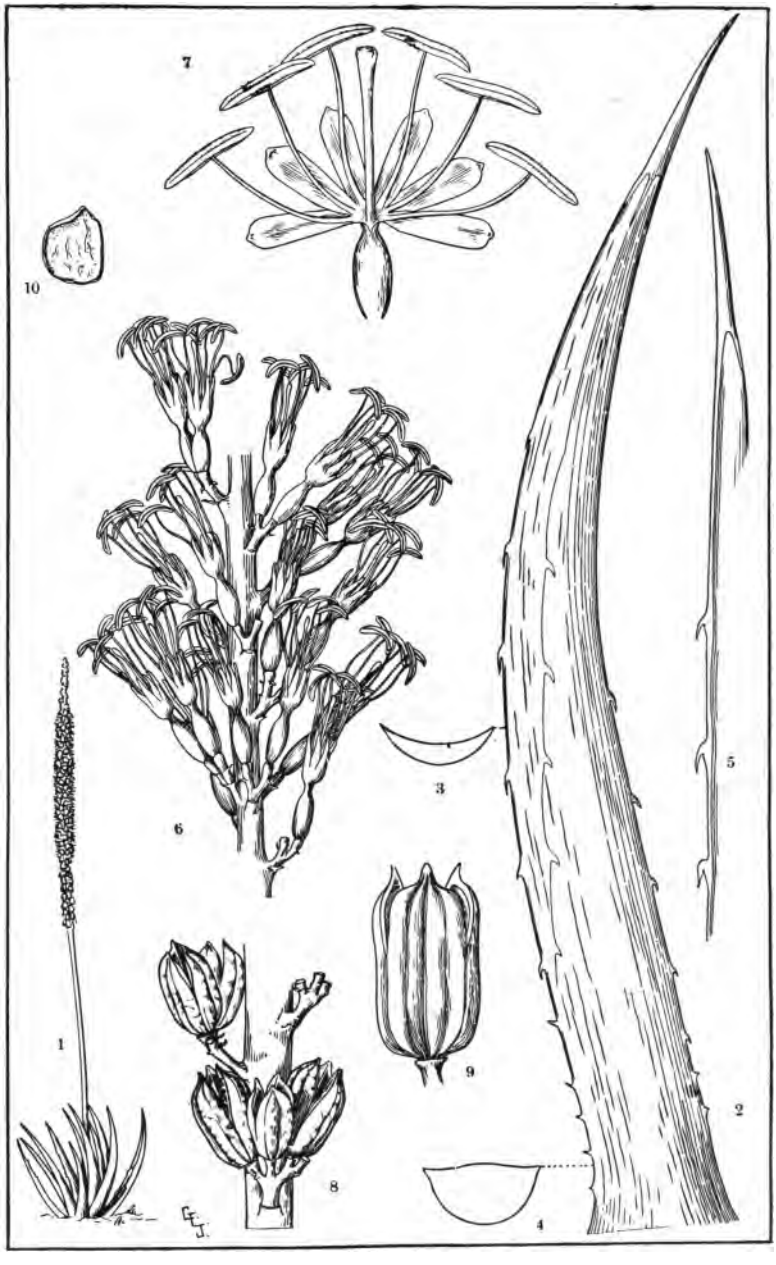

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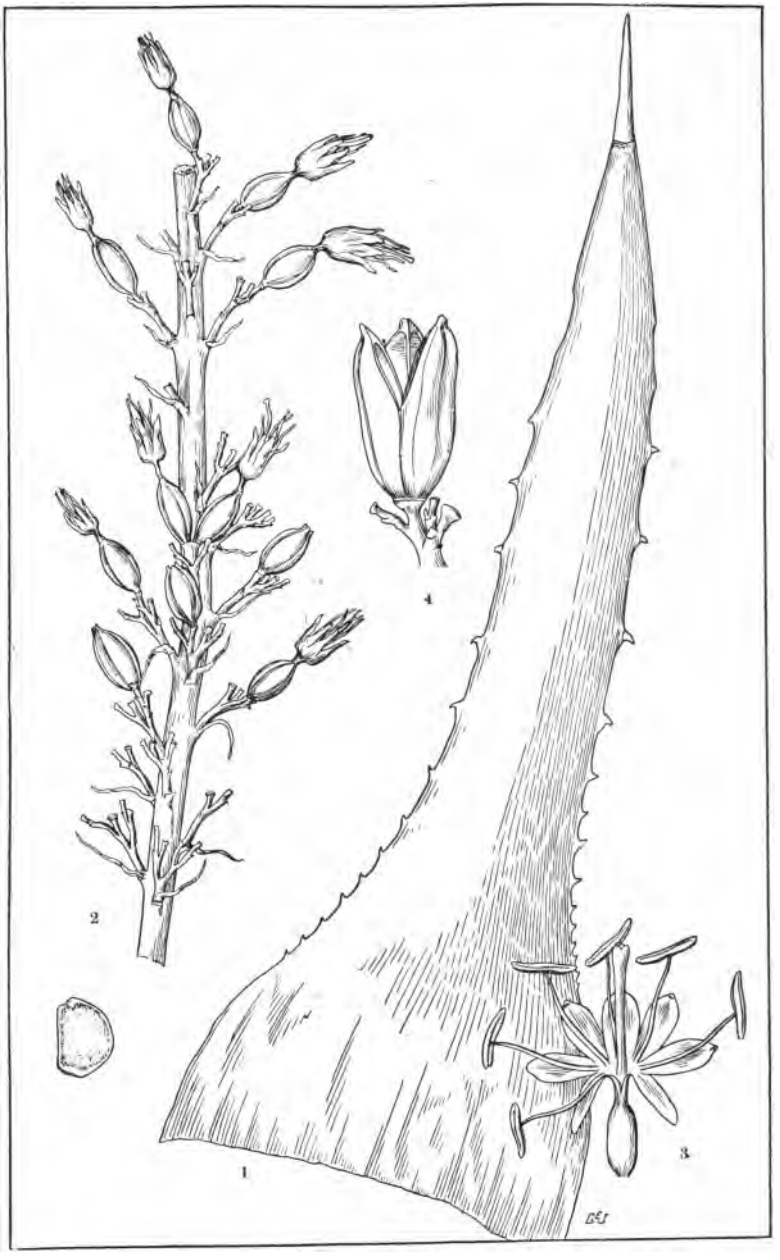

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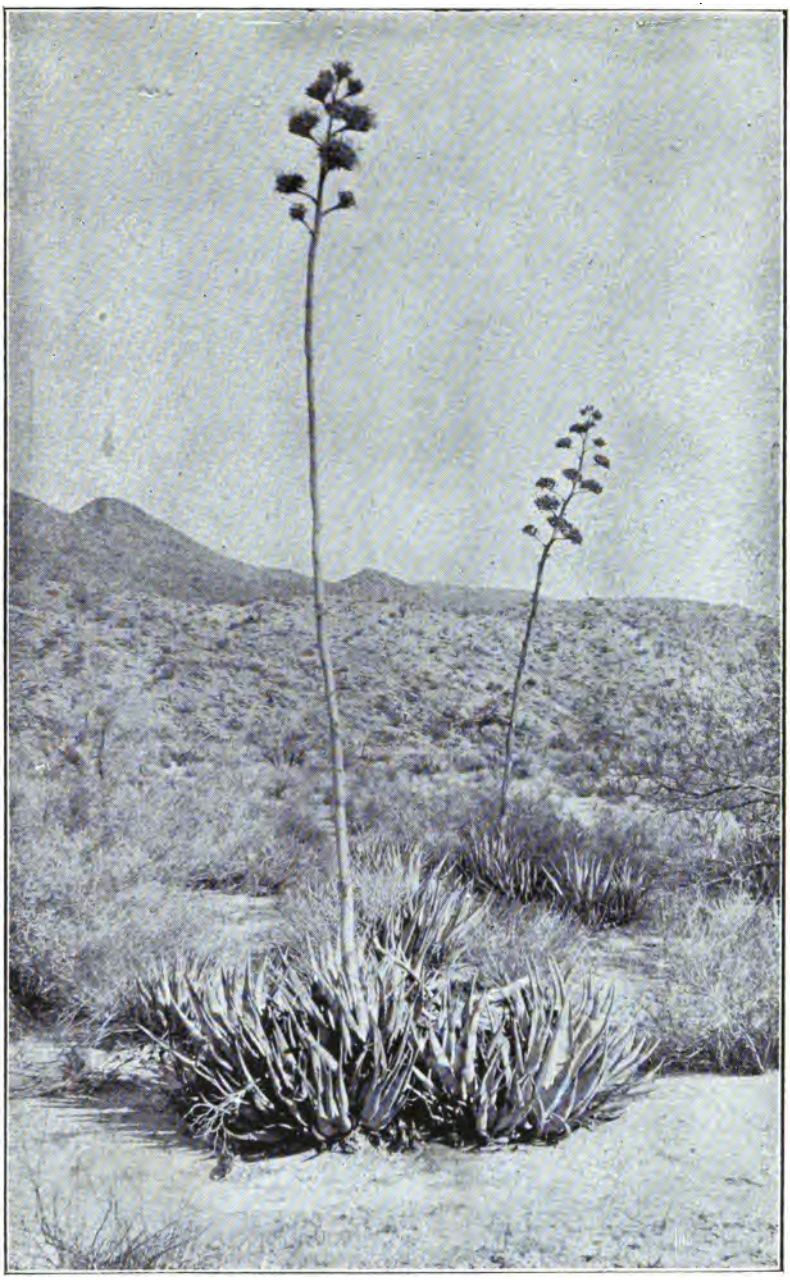

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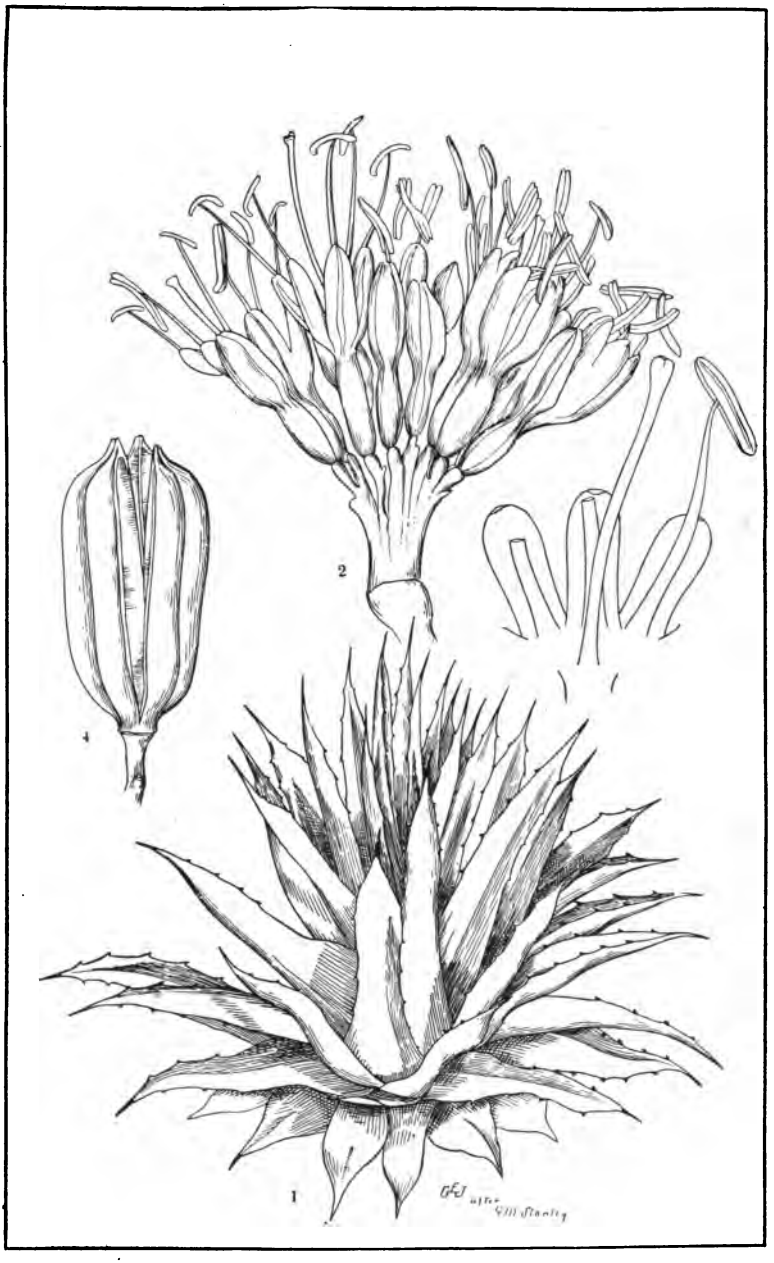
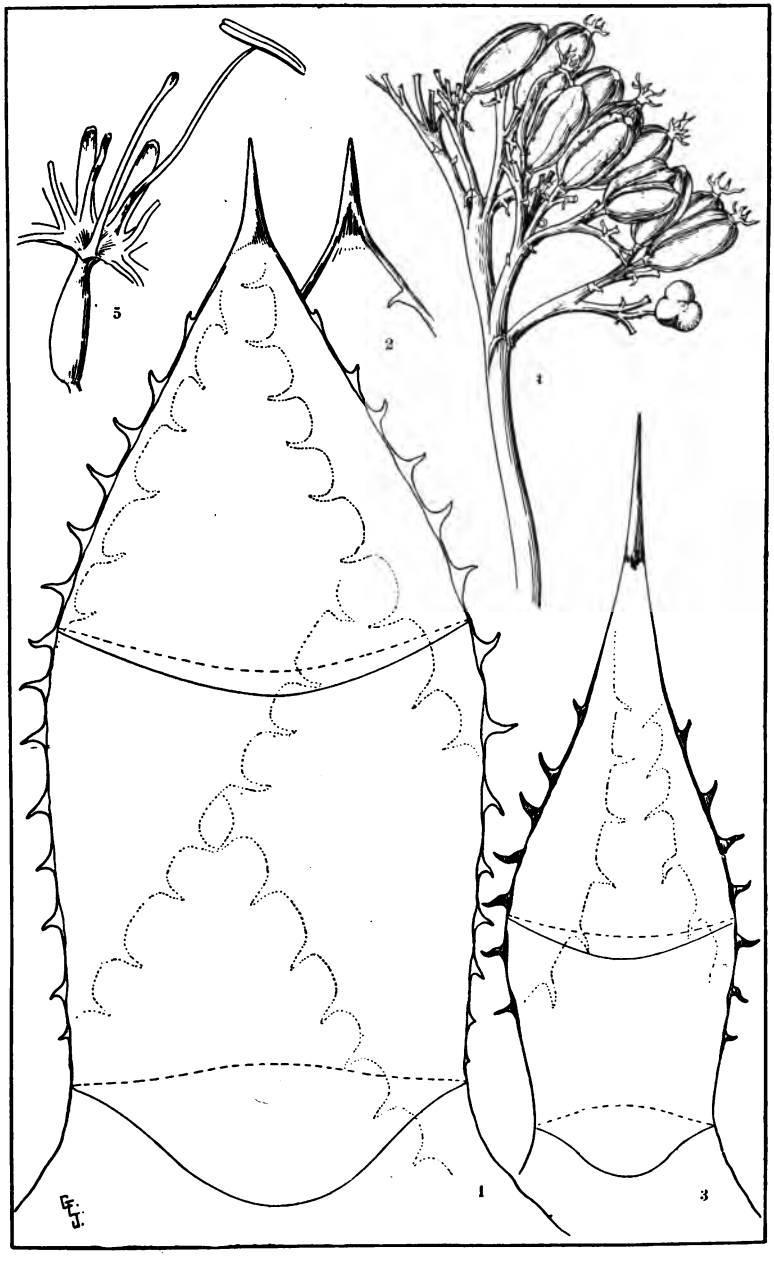


AGAVE DESERTI.

= A. gracilipes
apud Trelease
"Rivis cor..."
p. 55



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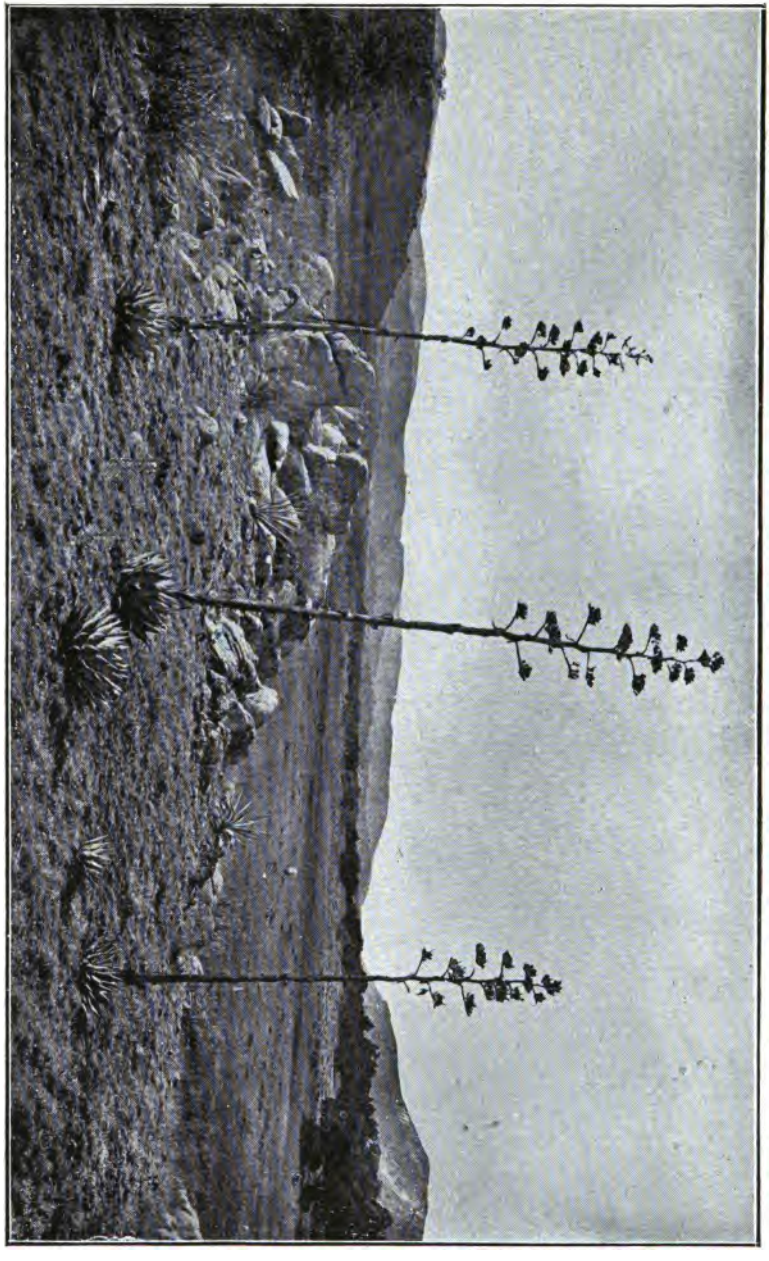
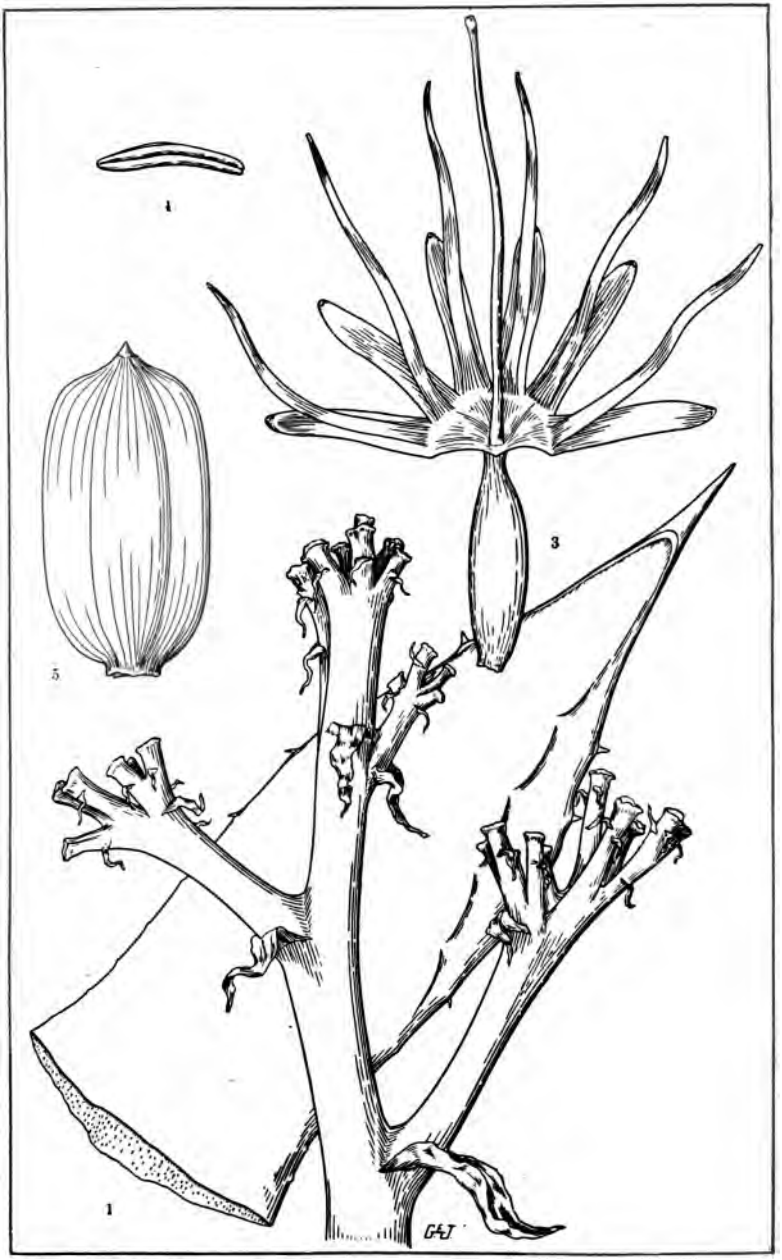


AGAVE APPLANATA, VAR. PARRYI.



AGAVE APPLANATA, VAR. PARRYI.

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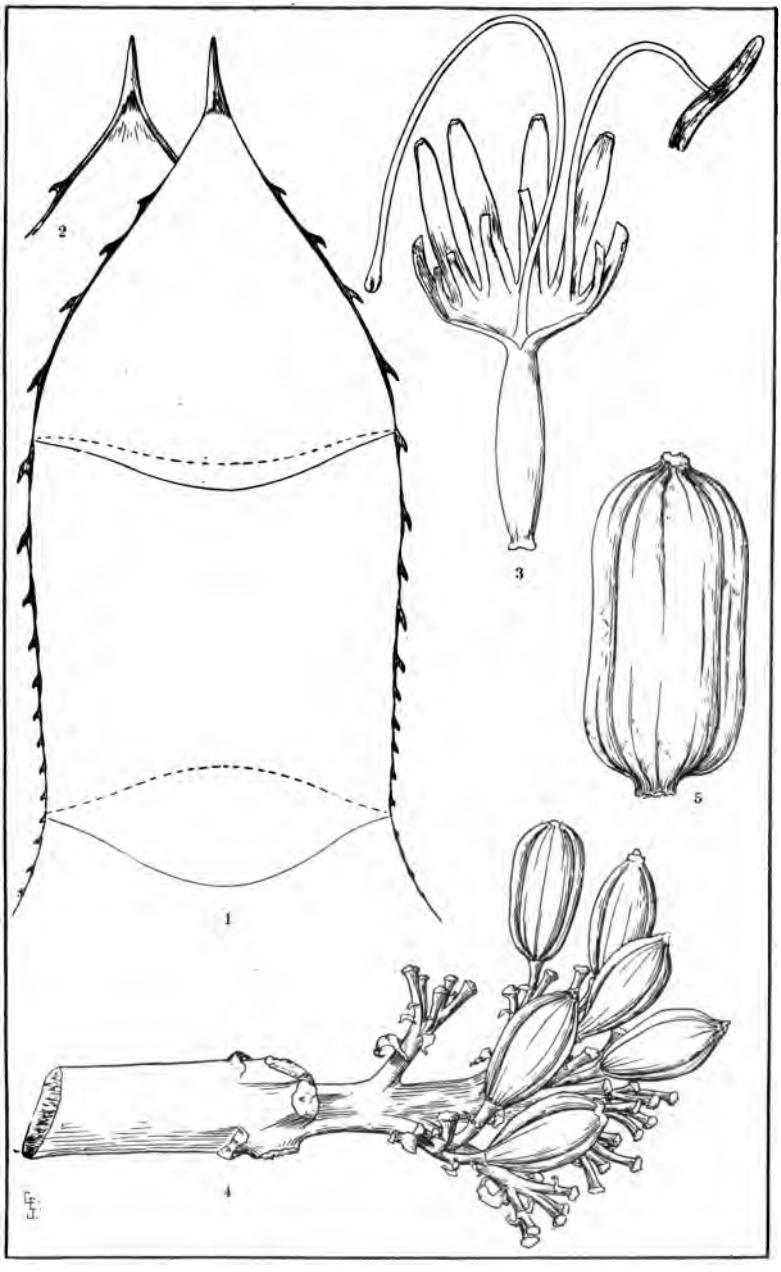

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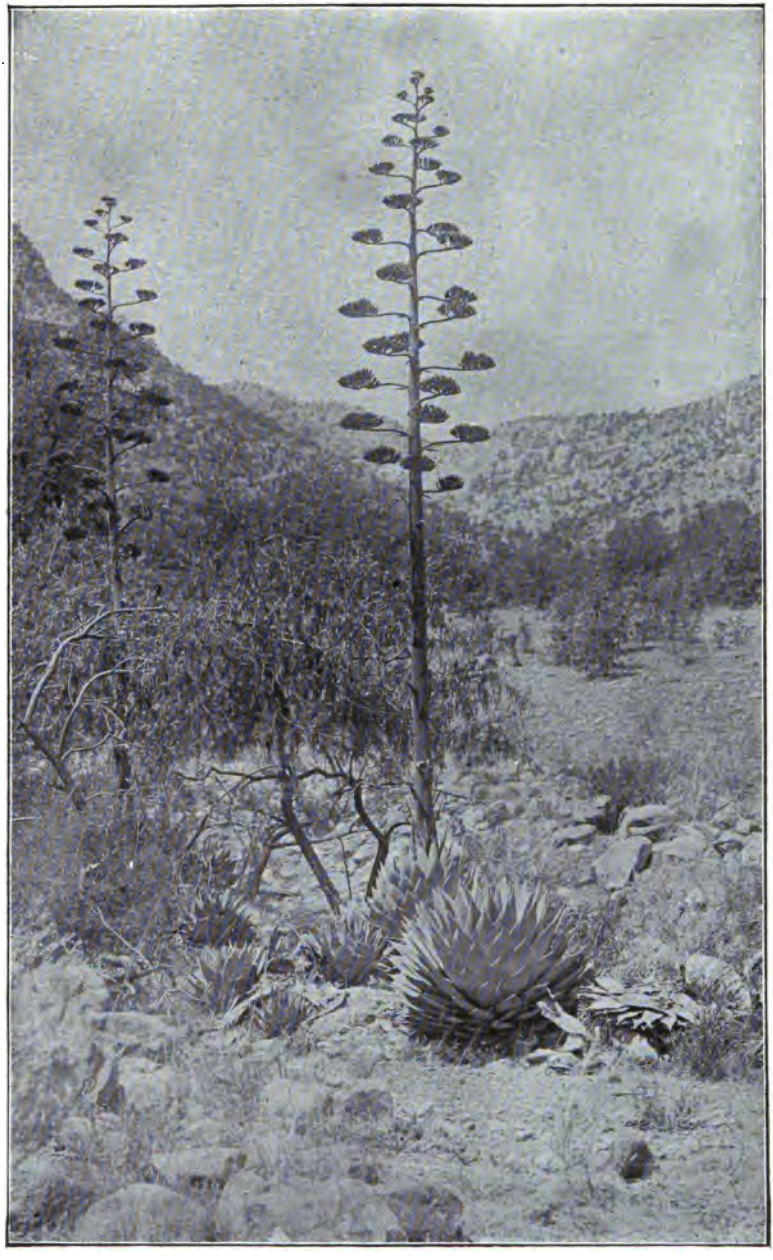
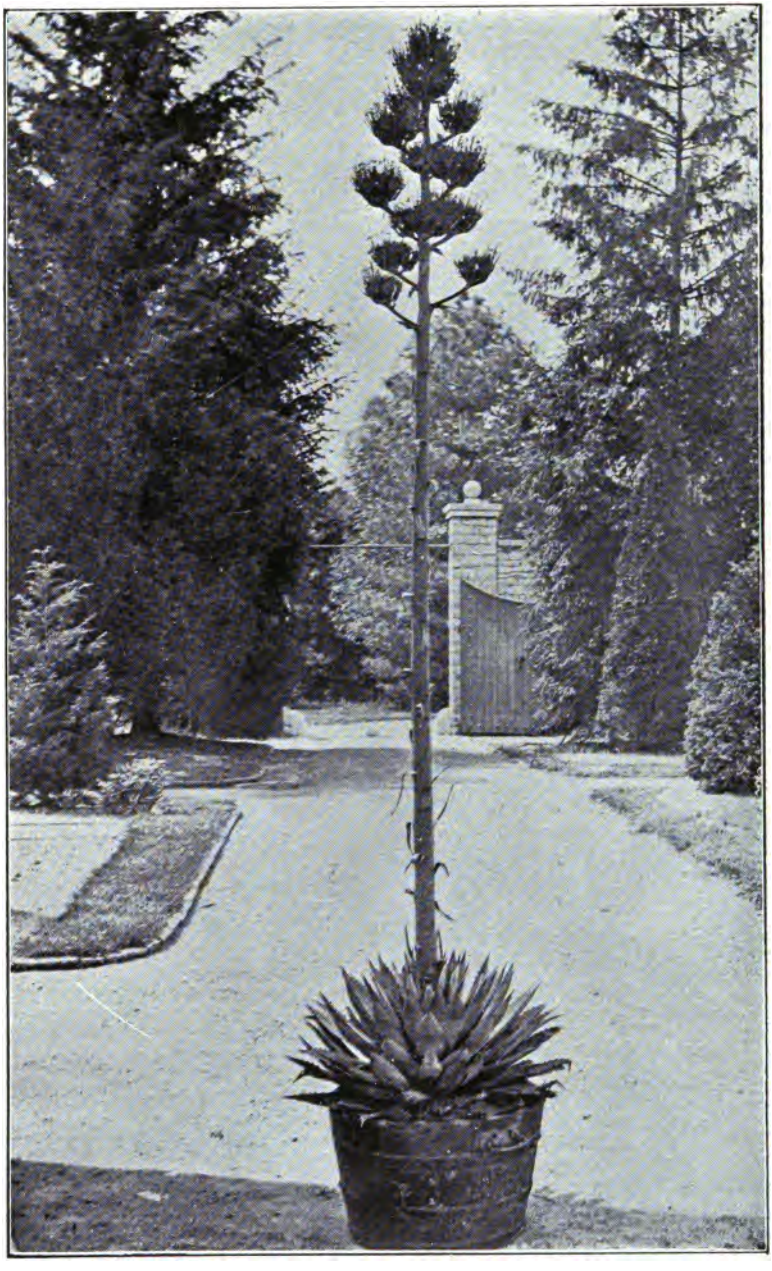


AGAVE APPLANATA, VAR. HUACHUCENSIS.

AGAVE APPLANATA, VAR. HUACHUCENSIS.



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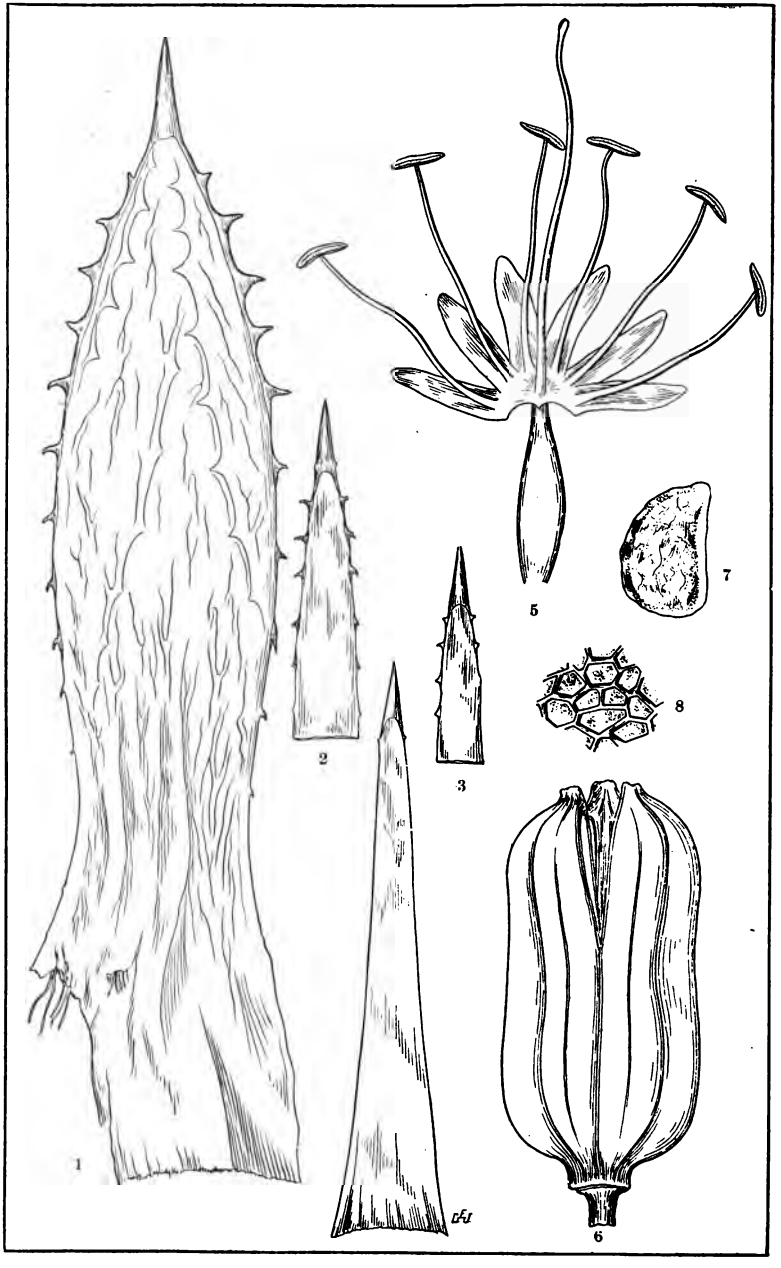

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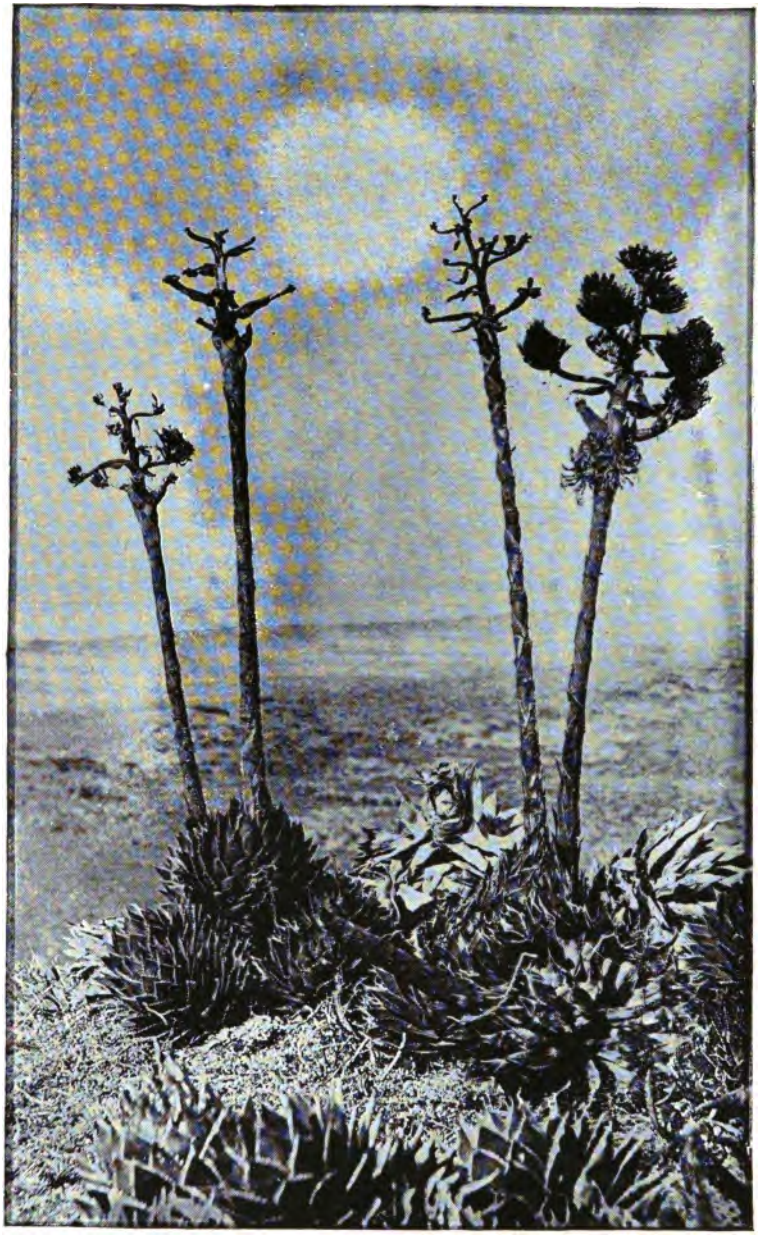
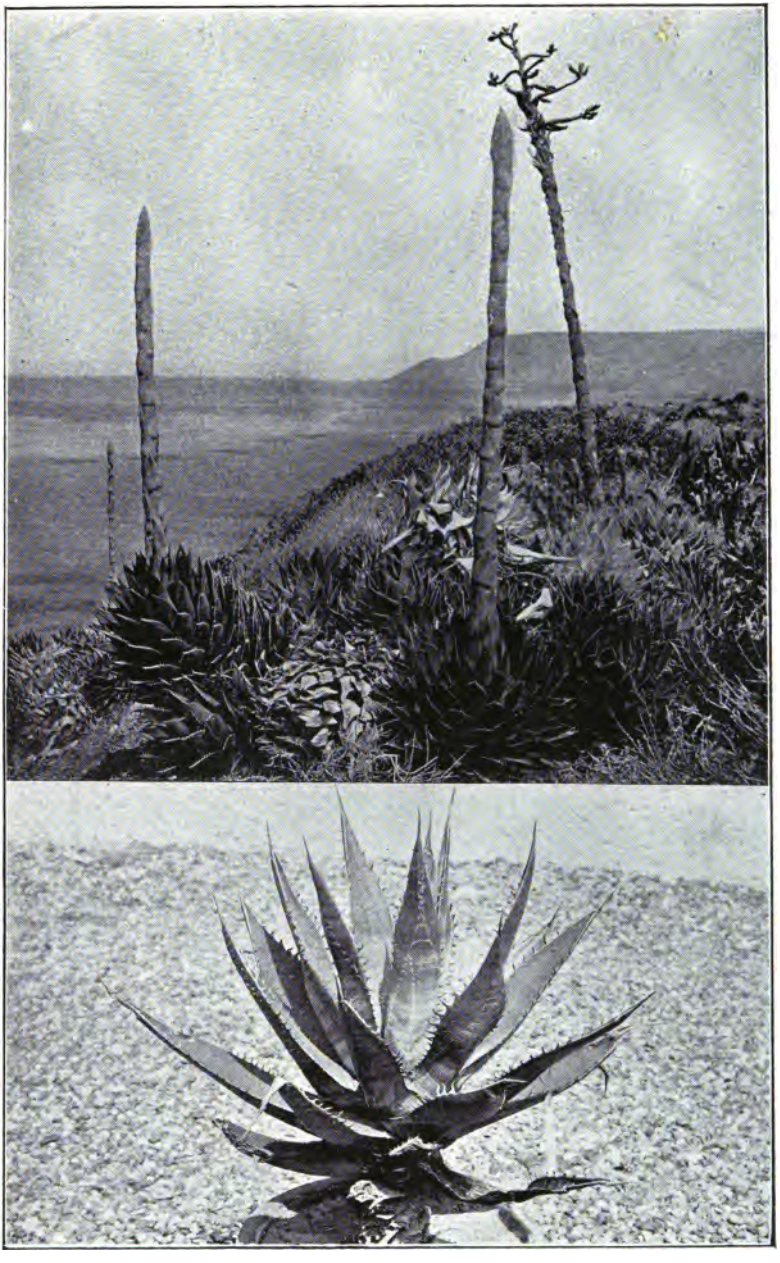


AGAVE SHAWII.



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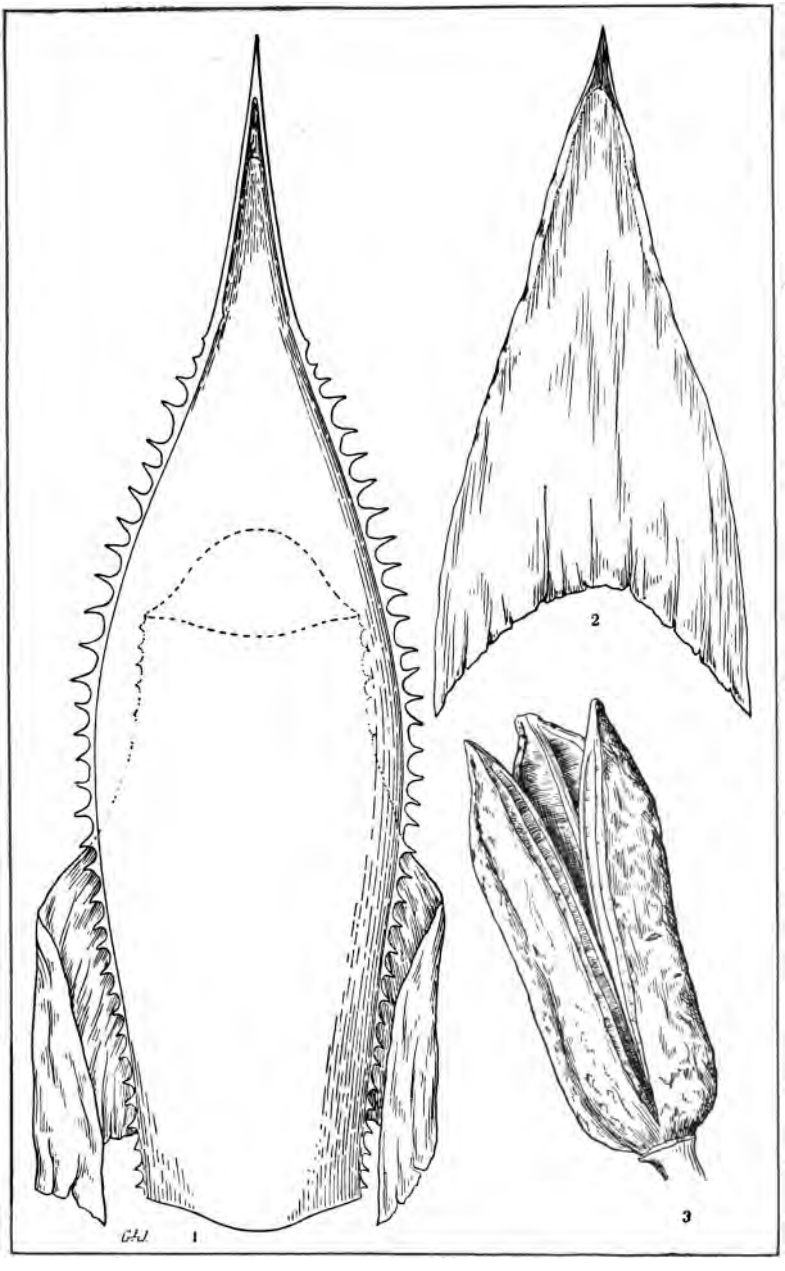

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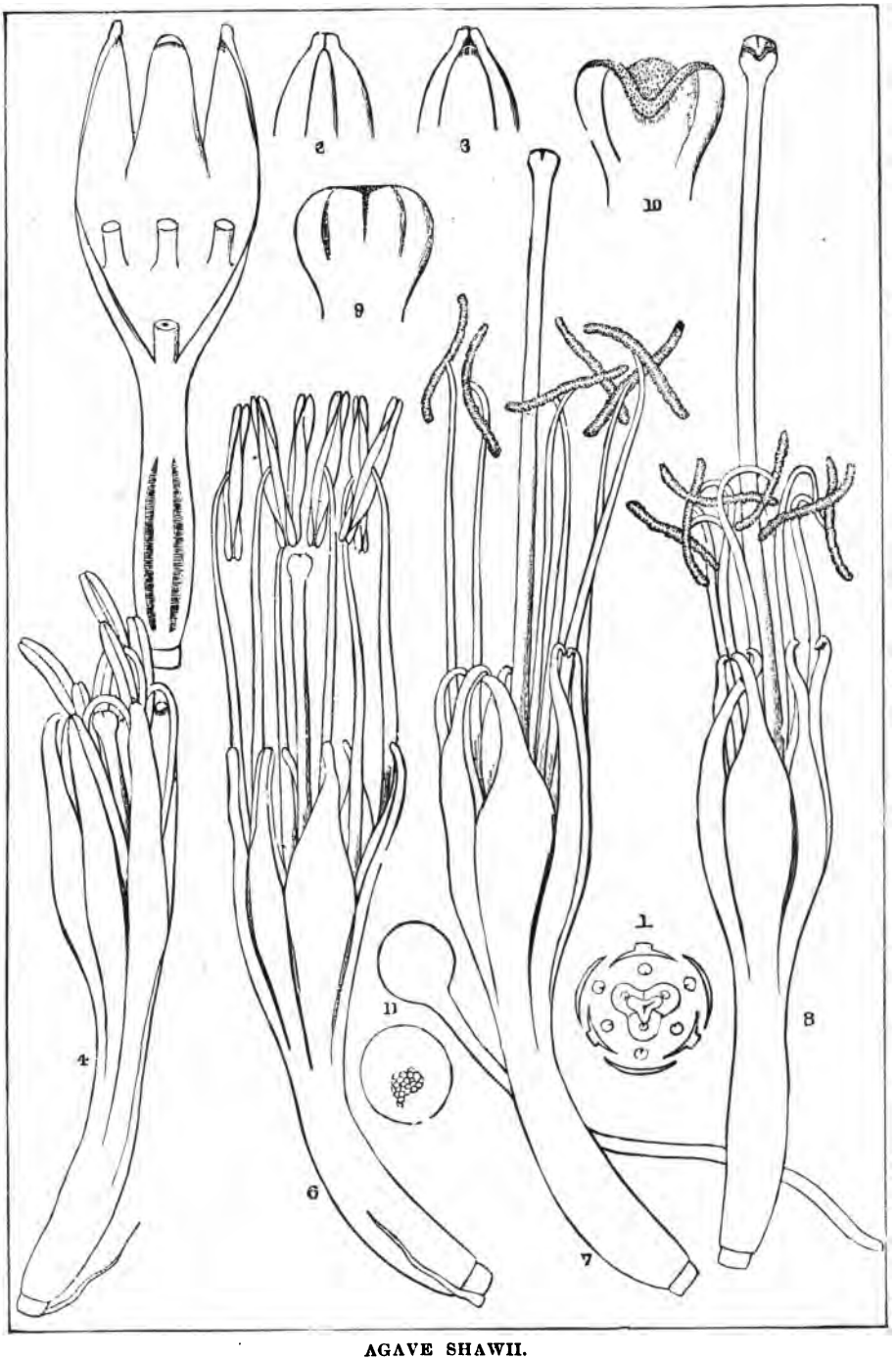

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AGAVE PALMERI.

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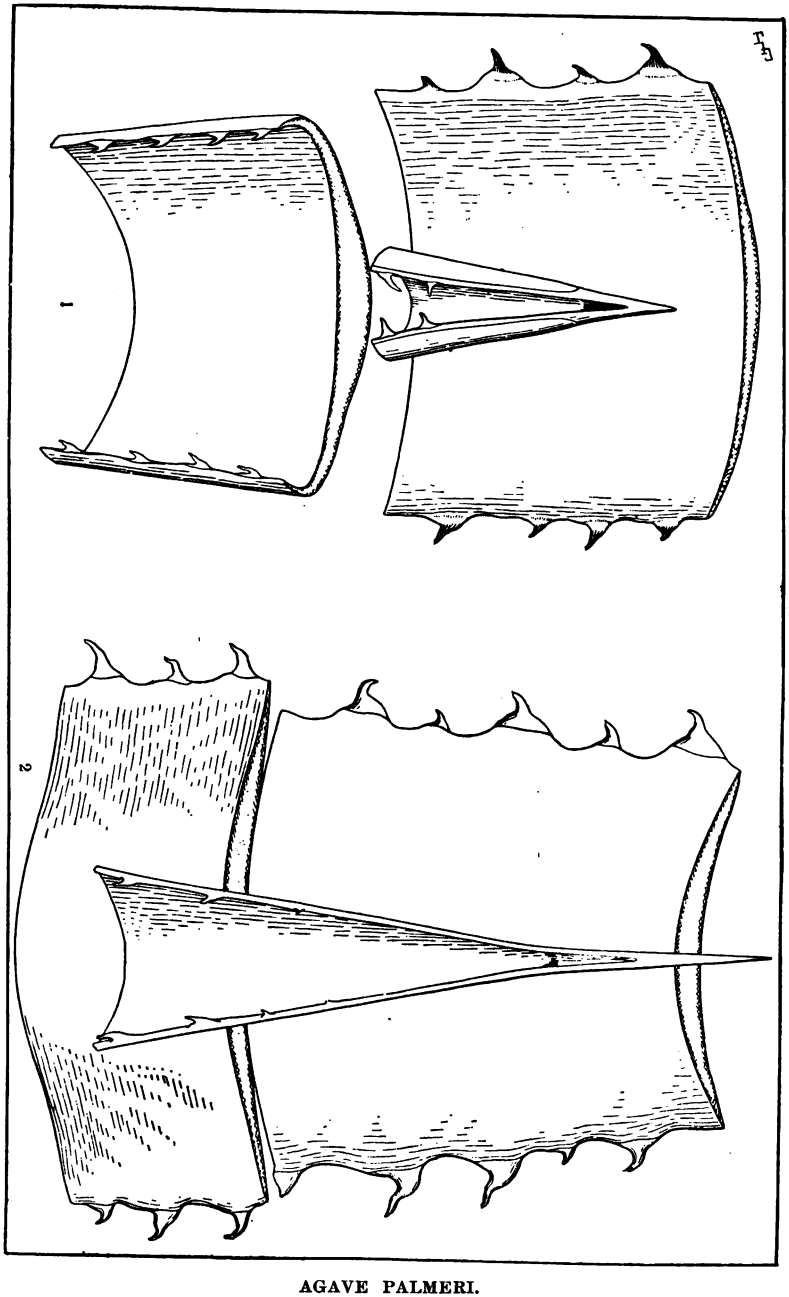

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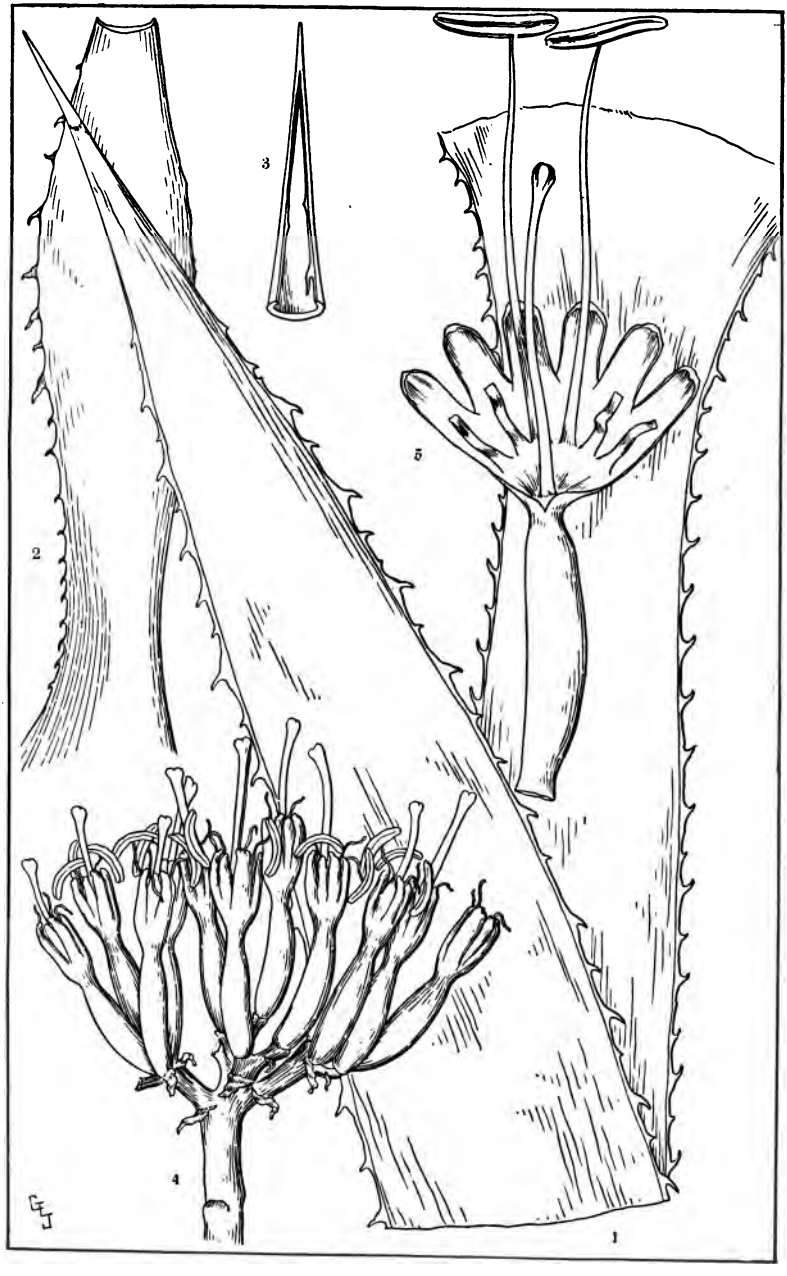

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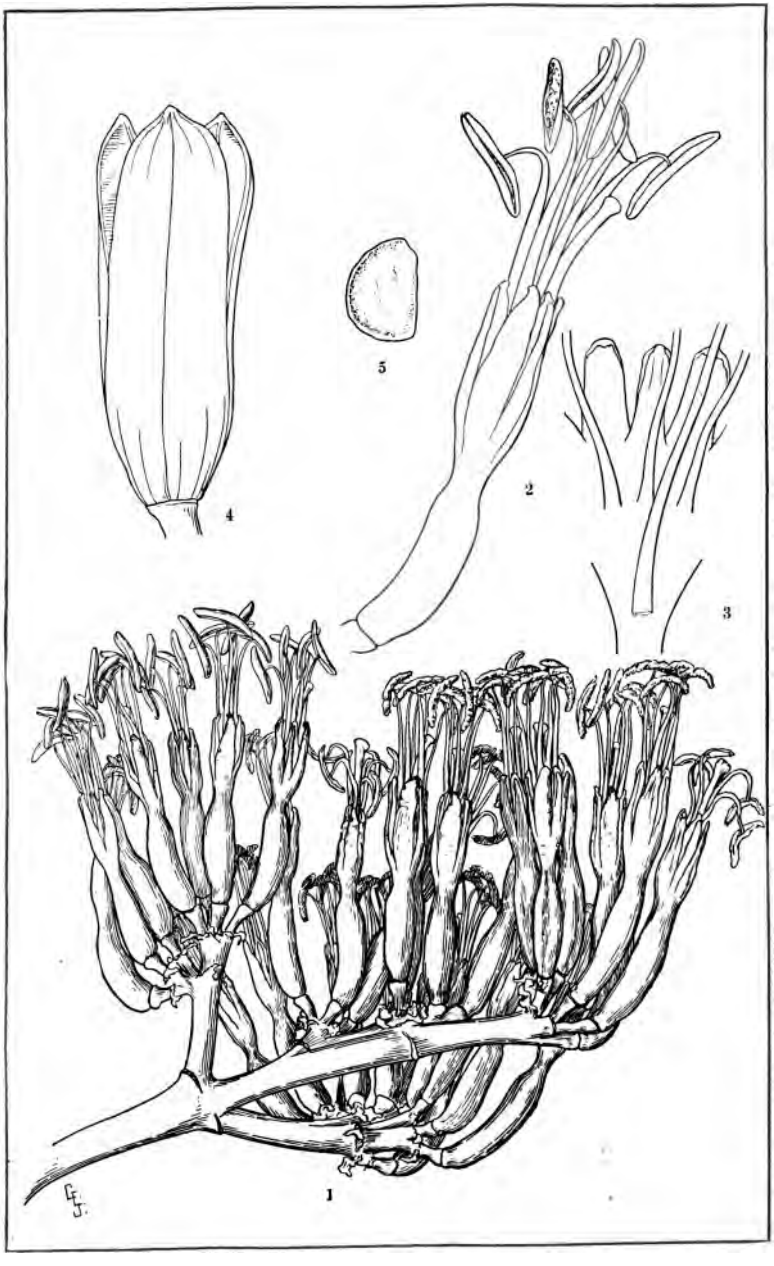

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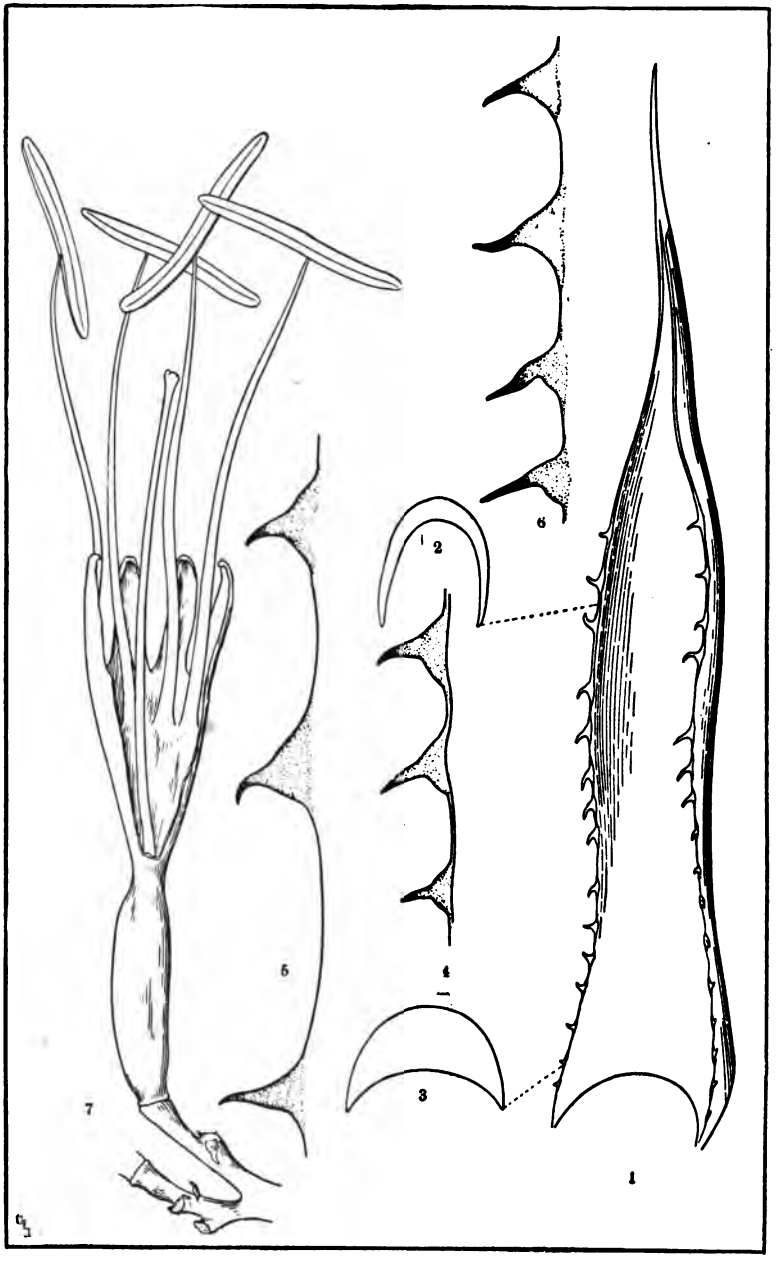

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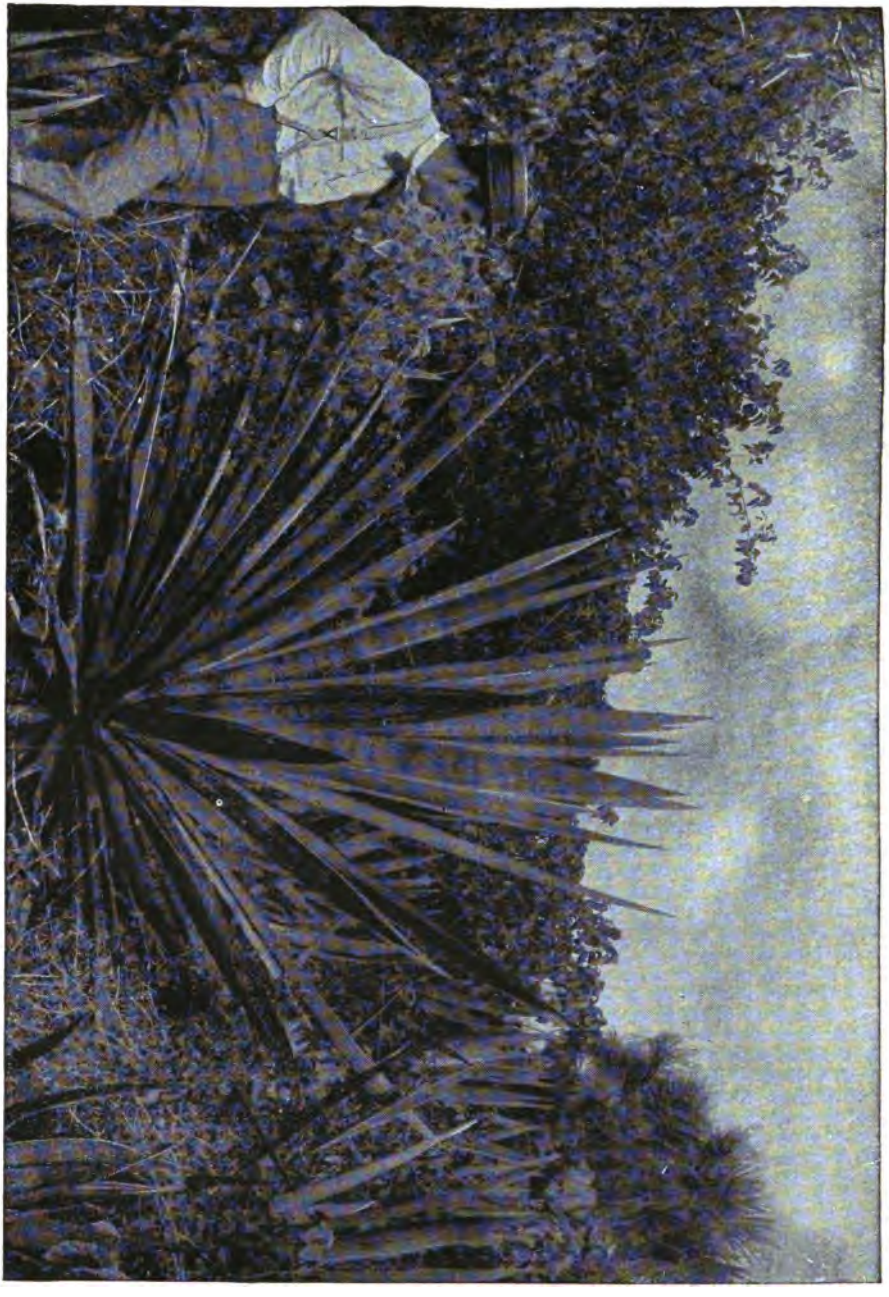

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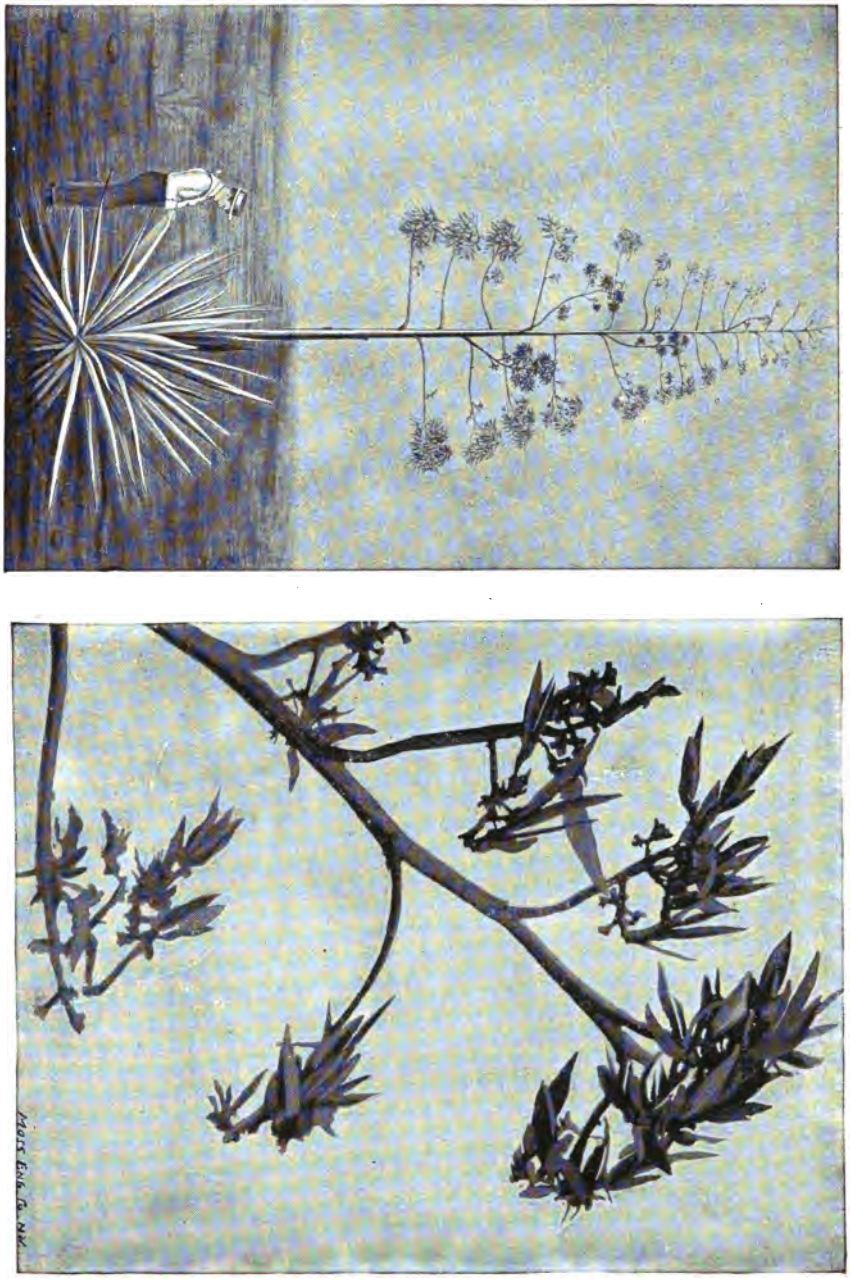

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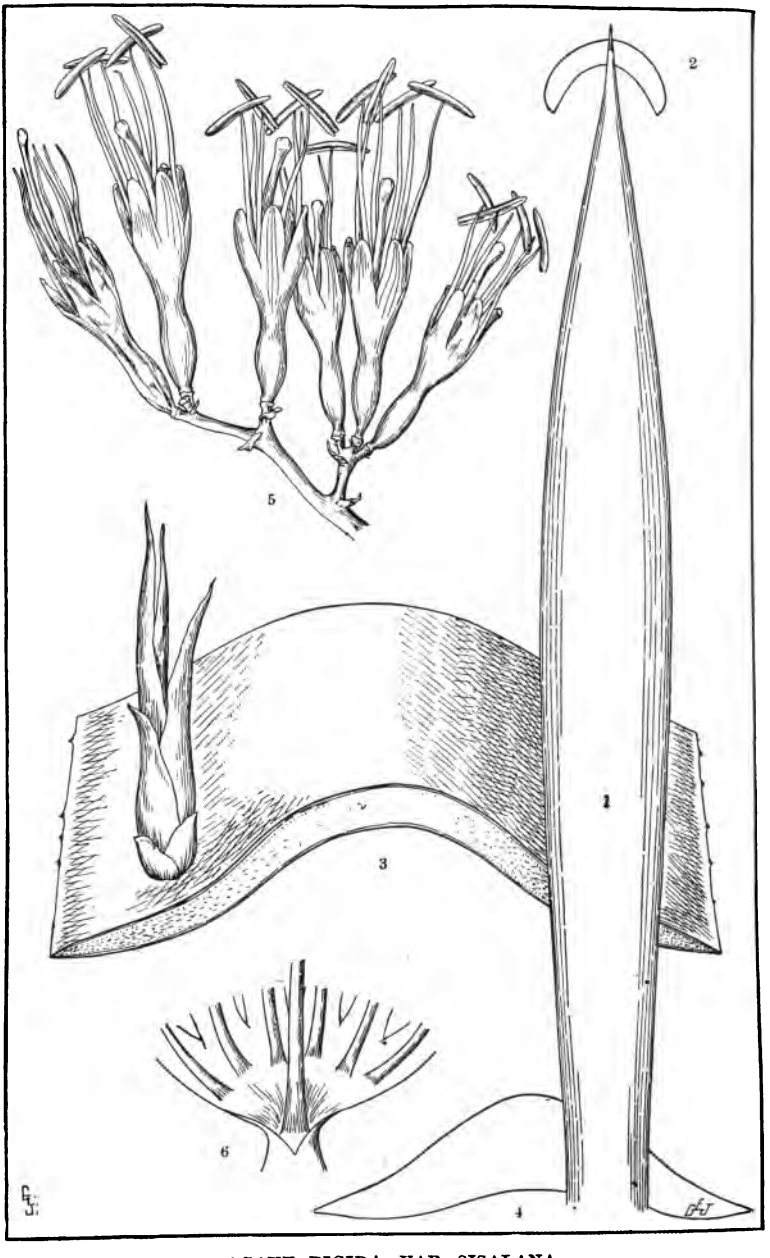

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AGAVE DECIPIENS.

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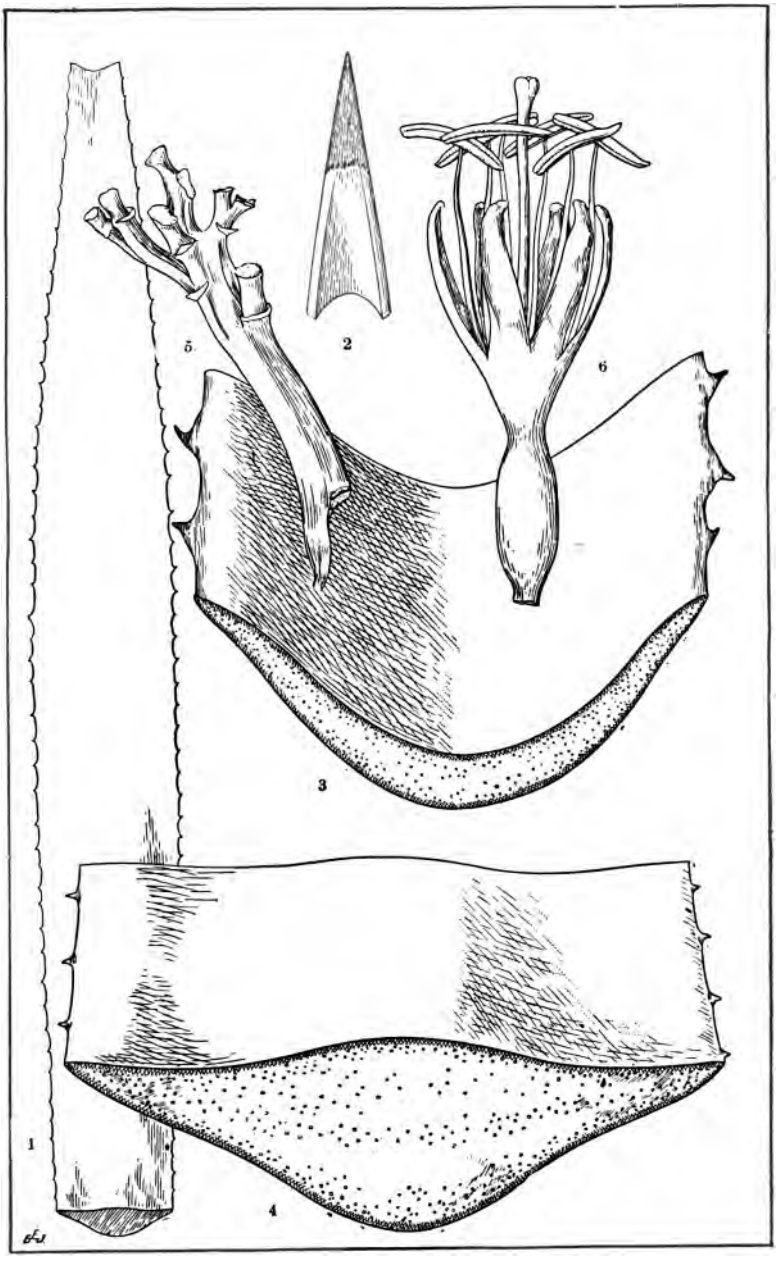

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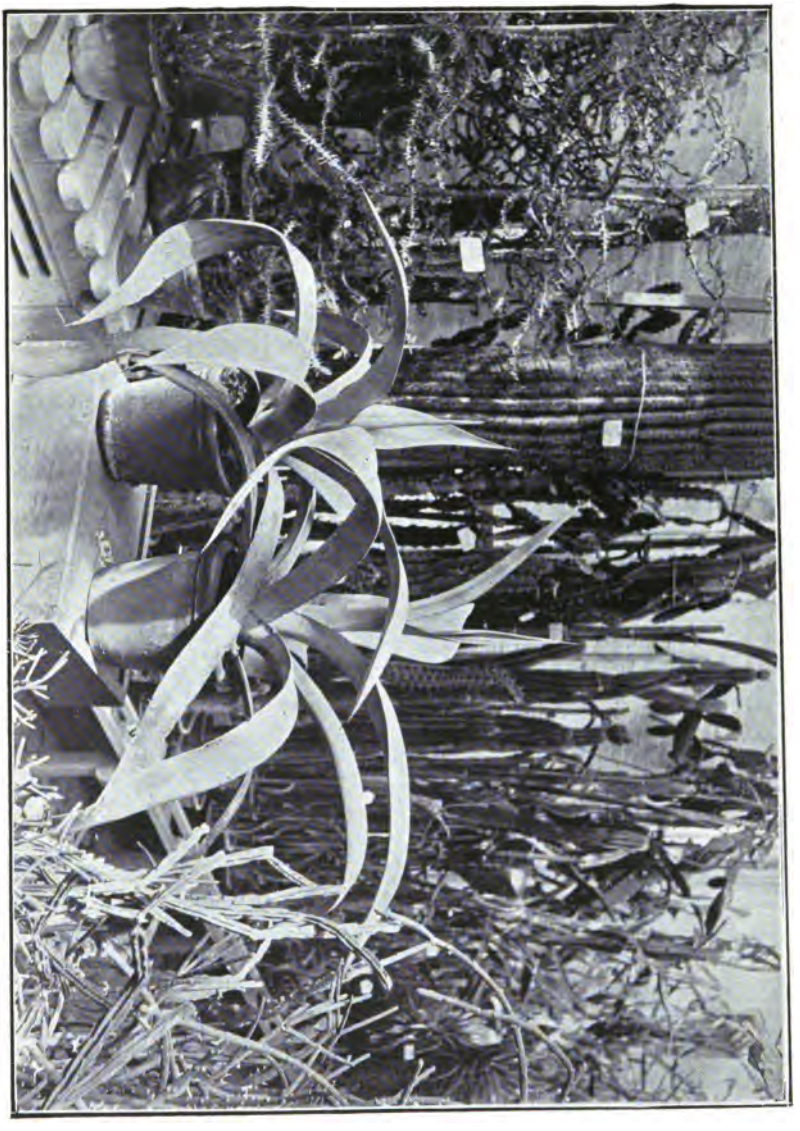

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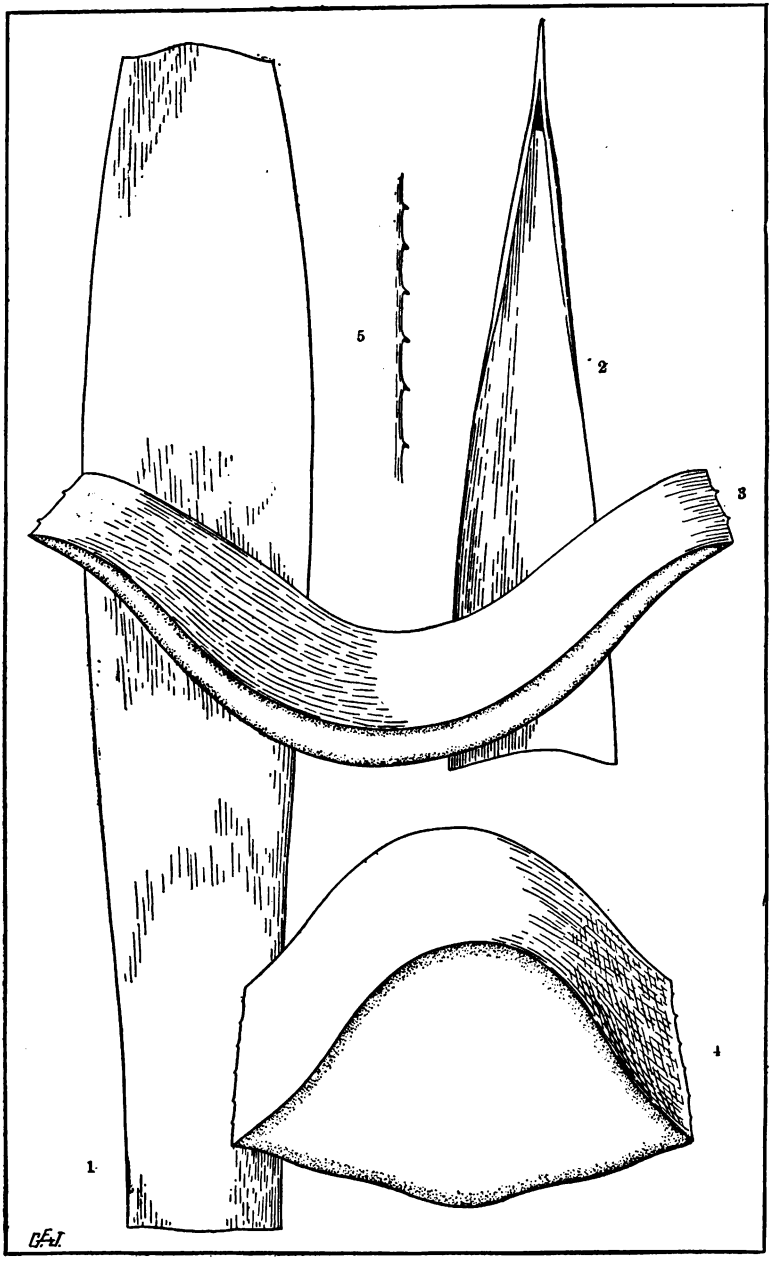
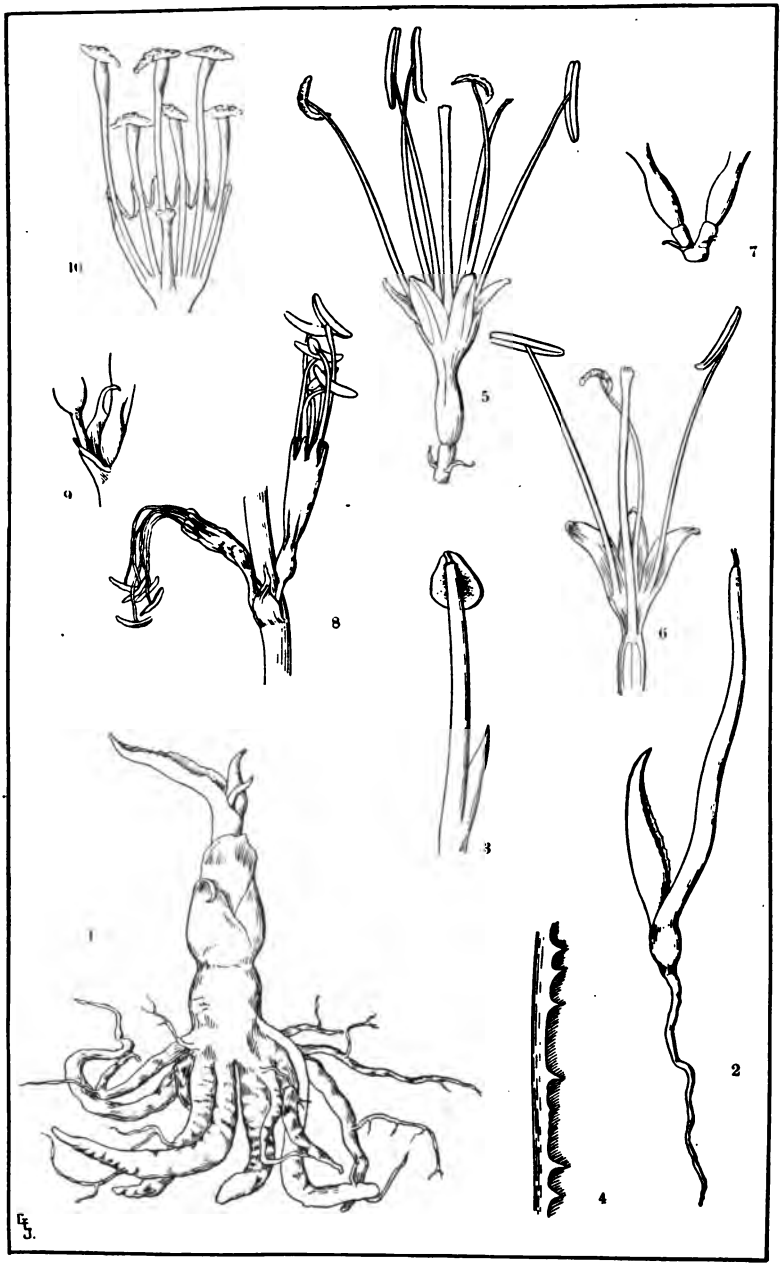
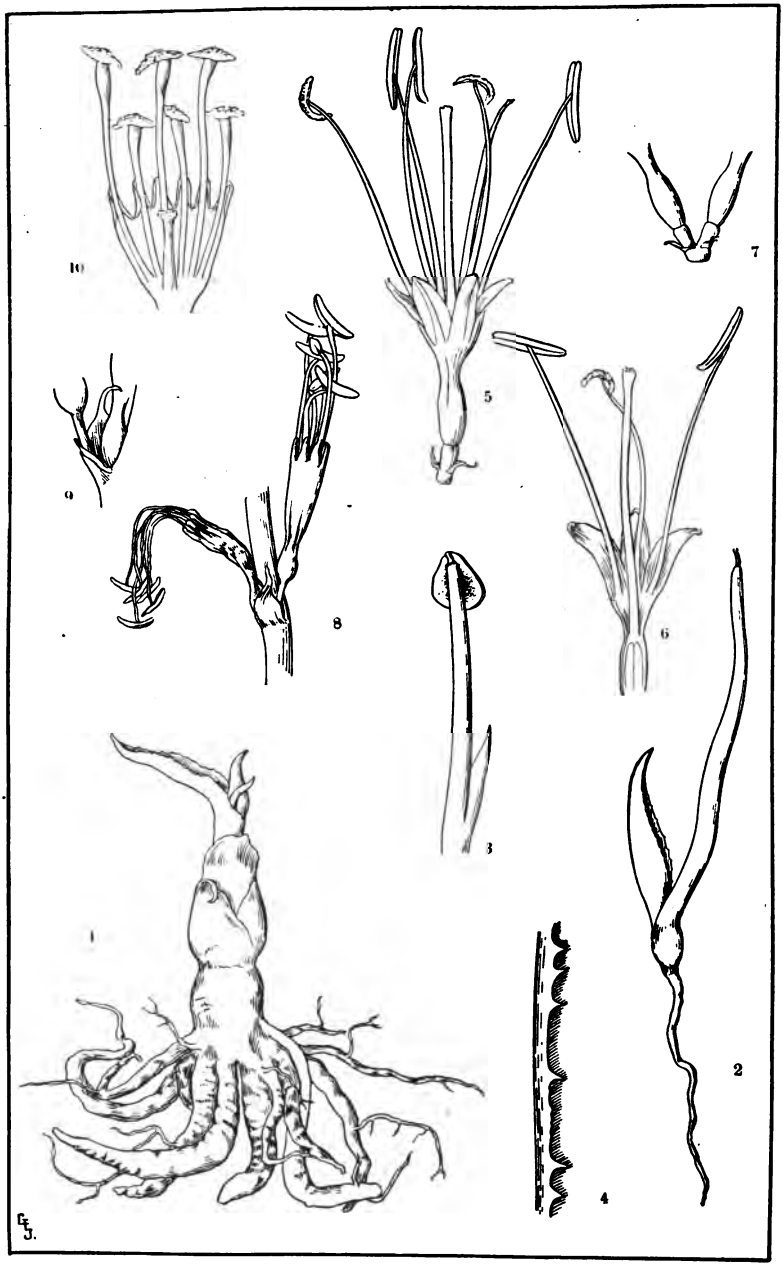


AGAVE SP.

AGAVE HORRIDA, VAR. MICRACANTHA.



DETAILS OF AGAVE.



DETAILS OF AGAVE.